



NAVAL POSTGRADUATE SCHOOL

MONTEREY, CALIFORNIA

THESIS

**HELP:
HANDHELD EMERGENCY LOGISTICS PROGRAM
FOR GENERATING STRUCTURED REQUESTS
FOR RESOURCES IN STRESSFUL CONDITIONS**

by

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September 2014

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**HELP: HANDHELD EMERGENCY LOGISTICS PROGRAM FOR
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CONDITIONS**

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ABSTRACT

The speed and efficacy with which front-line warfighters in stressful conditions can submit resource requests, such as a casualty evacuation, could mean the difference between life and death. Traditional methods to call for resources require training, are error-prone and can be sluggish. The Handheld Emergency Logistics Program (HELP) was developed by the authors of this thesis to assist both trained and untrained persons in requesting resources from supporting agencies. HELP was developed to prove the concept that off-the-shelf mobile technology can significantly improve the speed and efficacy of resource requests.

This thesis aims to allow HELP to exploit built-in sensors in modern commercial off-the-shelf handheld smart devices and their computation and communication capability to reduce the chance of error, reduce the need to pull information from memory, reduce manual data entry, and provide multiple redundant modalities for performing the same action.

Our findings indicate that with the assistance of HELP, users submitting resource requests committed half as many errors and completed the request in half the amount of time as compared to a control group using traditional methods. We recommend that the concept of using smart devices to call for resources be further developed into a program of record.

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LIST OF ACRONYMS AND ABBREVIATIONS

AO	area of operations
APP	application
CASEVAC	casualty evacuation
COC	combat operations center
COTS	commercial off-the-shelf
CBRNE	chemical, biological, radiological, nuclear explosive
DoD	Department of Defense
DOS	days of supply
EOD	explosive ordnance disposal
GPS	global positioning satellite
GUI	graphical user interface
HA/DR	humanitarian assistance / disaster relief
HCI	human-computer interaction
HELP	Handheld Emergency Logistics Program
HVHF	high velocity human factors
IED	improvised explosive device
LZ	landing zone
LTE	long term evolution
MEDEVAC	medical evacuation
MGRS	military grid reference system
MSR	main supply route
NATO	North American Treaty Organization
NCO	non-commissioned officer
NBC	nuclear, biological, chemical
NSA	National Security Agency
PAX	number of personnel
PC	personal computer
PLT	platoon
PME	professional military education
SOI	School of Infantry

UI	user interface
USMC	United States Marine Corps
UXO	unexploded ordnance

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I. INTRODUCTION

A. MOTIVATION

The authors recently returned from combat deployments prior to arrival at the Naval Postgraduate School. On several occasions during deployment, we were required to call for support from higher headquarters. One of the most important items on our pre-combat checklists was the “smart pack” of request formats. A “smart pack” is a compact booklet full of laminated sheets that contains request formats for anything from casualty evacuations to explosive ordnance disposal support.

Resource requests are typically specifically formatted to give the supporting agency all of the information required to provide assistance to the requestor. Most resource requests require the requestor to provide common information, such as location, contact information, and unit information. All requests also require information specific to the type of request (e.g., casualty information, pickup location). Typically, these requests are made during times of stress. For example, a Marine requesting evacuation of a casualty is likely under fire and possibly assisting with treatment and triage procedures.

Our deployments were in different places with different missions, but we both independently recognized that there *had* to be a better way to call for support. During an after action review (AAR) from a mission that required a casualty to be evacuated, we discussed how the call for evacuation was very time consuming and added a great deal of stress to an already stressful situation. When discussing what was eventually a successful casualty evacuation, one of the Marines in the AAR joked, “Shouldn’t there be an app for that?” He posed a very legitimate question. Why in the age of near-instant communication are warfighters still lugging around large notebooks, formulating resource requests by hand, only then to transmit the requests over a voice radio?

B. PROBLEM STATEMENT

There currently exists no mobile application that runs on multiple devices to assist a front line warfighter to call for logistics resources. In the current military process, one’s ability to call for assistance is often challenged by several factors:

- Training. A warfighter must receive initial and sustainment training using the prescribed formats in order to efficiently and effectively request resources.
- Human Errors. Irrespective of the level of training, resource requests are prone to errors both in formulation and during voice transmission.
- Time. Manually formulating the request and submitting the request to higher headquarters takes a considerable amount of time. Often, when requests for assistance are made, time is usually limited and wasted seconds can be catastrophic.
- Stress. When calling for assistance, the conditions are rarely ideal and compound the previous three factors.

We propose to address this problem through the development of HELP: Handheld Emergency Logistics Program, an application suite that can exploit embedded smartphone functionality to assist the warfighter [1]. Smartphones have a great deal of computational power, many built-in sensors and communication capability that can be used to alleviate many of the problems associated with resource requests. We will leverage the technology in the devices to:

- Provide a simple, common user interface. This will limit the required training, decrease human errors, and decrease overall transmission time.
- Use device sensors when possible in order to alleviate human errors and to make the process faster.
- Use the devices' inherent digital communication capability in order to speed up transmission.
- Provide visual and tactile feedback in order to assist the user as much as possible during stressful situations.

Our hypothesis is that the use of a well-developed application suite to replace traditional resource request methods will result in a significant decrease in errors and the overall time required to make resource requests [1].

C. RESEARCH QUESTIONS

Primary Research Question: What is a suitable software architecture for a commercial off-the-shelf (COTS) handheld system to assist an untrained Marine or Soldier call for resources?

Secondary research questions:

- Which sensing modalities of current COTS mobile devices can be used to facilitate rapid request generation?
- What measures can be taken to prevent errors in the generation of call for resources?
- What measures can be taken to make the application usable in stressful environments?
- What are the time and accuracy benefits to using a handheld device compared with traditional methods?
- Can an untrained Marine or Soldier use the device with little or no prior training?
- What are the security concerns when dealing with individual mobile devices?

D. SCOPE AND LIMITATIONS

This work is inspired by a request from the United States Marine Corps Installations and Logistics Command. They seek to leverage current commercial technology to assist with calls for resources. This is based upon experience and after-action reports from many units returning from deployments.

Our research has been conducted in several phases:

- Research the current table of equipment for USMC infantry companies.
- Research training and readiness standards for company level leadership.
- Develop an architecture for a new COTS device-based systems
- Design, develop, and test select resource request applications
- Resolution of issues
- Command post exercise (CPX) aboard Naval Postgraduate School
- Refinement of application/architecture resultant from CPX
- Field testing of our system in a scenario-driven exercise utilizing live assets

It is not within the scope of this thesis to begin any security certification and accreditation efforts.

E. METHODOLOGY

We began our research by reviewing the current digital communications capability available at a line infantry company. We then built a test and evaluation network at Naval Postgraduate School that was configured as a company combat operations center (COC) using the available equipment set.

Upon completion of the test network, we designed and created a native application on an Android device.

Upon completion of the application, we tested the connectivity and validated the desired capability.

After proper implementation of the application, we researched the training required to familiarize users with the application.

As a final proof of concept, we arranged to test the application suite with students awaiting training at the USMC Marine Detachment at the Defense Language Institute.

F. THESIS ORGANIZATION

Chapter I discusses the purpose of the HELP suite of applications and why there is a need for this type of system.

Chapter II discusses the background of digital resource request formats as well as an in-depth history of medical evacuations, explosive ordnance disposal and logistics requests. This provides some background on the importance of request structure and demonstrates the complexity of some of the formats.

Chapter III discusses the design and development of the HELP suite of applications. We outline the applications' design and functionality and document the screen-by-screen usage and user-interface (UI).

Chapter IV outlines the testing and evaluation of the prototype suite of applications.

Chapter V presents the conclusions of our study and makes recommendations for future work. The HELP suite source code can be used as a shell for a variety of different resource requests.

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II. BACKGROUND

Handheld digital devices are fairly common throughout the military. In our experience, such devices have one commonality: these digital devices perform a single task. For example, in 2002, the Artillery community was given a digital device called “Pocket-Sized Forward Entry Device” (PFED) to call for artillery fires. The device was built around a modified Palm device and could perform the single task of calling for artillery fires. A few years later, the Artillery community was then given a different Palm-based device (Centaur) to compute firing data. Again, the hardware could perform a single task: computing firing data. The Infantry community has had different iterations of a handheld computer to compute firing data called the Mortar Ballistic Computer (MBC). This device also performed a single task: computing firing data.

Hardware development has a significant cost associated with the end-item deployment, as these systems are typically built from scratch or modified from existing technology [2]. Our research focus has been to use existing commercially available hardware and aggressively use the capabilities inherent in these devices to maximize efficiency. COTS smart devices are very common and provide an enormous capability in terms of functionality, communications capability and computing power.

During any combat mission, there will be a need to request resources and support from supporting headquarters. A small unit (team, squad, or platoon) only has a finite amount of organic or local capability. Requests for specialized support are currently transmitted and coordinated via radio to the unit’s supporting headquarters. Our research goal is to provide a better way for front-line units to transmit these requests using commercial devices. As a baseline proof of concept for using a smart device to transmit requests, we chose three common requests: casualty evacuation (CASEVAC), explosive ordnance disposal (EOD) and rapid logistics request.

A. CASUALTY EVACUATIONS

Casualties have always been a part of warfare and often a part of significant natural or man-made disasters. Until recently, the care of casualties was primitive at best

and many perished through a lack of understanding of medicine and hygiene. To complicate matters, many of the wounded lay on the battlefield for days (and in some cases weeks) before they were taken to a field hospital. Undoubtedly, many individuals died from untreated wounds while lying awaiting treatment. Over the last 500 years, for every soldier killed in battle, there has been an average of 4 wounded during the battle [3]. In addition, of those wounded, approximately one-third of those soldiers needed serious medical treatment for their injuries [3].

It was not until the Civil War that the United States developed a formal means of evacuating the wounded off the battlefield [3]. Dr. Jonathan Letterman created a system for the Army of the Potomac to efficiently and effectively evacuate the wounded. He instituted the use of triage, ambulances, and field hospitals. These contributions helped earned him the title of “Father of Modern Battlefield Medicine” [4]. The practices that he instituted helped drive down the 20+% hospital mortality rate at the start of the war down to 10% by the time of Gettysburg [3]. The military continued to improve on the basic principles of battle evacuation that were introduced in the Civil War. The military leveraged technology and advancements in medical technology to continue to decrease the mortality rate of soldiers on the battlefield even as the lethality of weaponry increased. Many lessons were learned the hard way from World War II through the Vietnam conflict, from the importance of treating for shock to leveraging helicopters to evacuate the wounded. However, these lessons paid off and during the World War II, Korean, and Vietnam wars the hospital mortality rate was between 2.4 and 2.6 percent [3].

While the basics of rapid evacuation from the battlefield is no different today than in the past, we have past successes and failures from which to draw experience [3]. One of the key lessons learned from past conflicts was the importance of the “Golden Hour.” The “Golden Hour” is the concept that if a severely wounded soldier receives “surgery or advanced trauma life support” within the first hour he injured, his chances of survival are dramatically increased [5]. The past and present data from Operation Iraqi Freedom and Operation Enduring Freedom provides surprising statistical information on how important the “Golden Hour” truly is. The data shows that “90 percent of all casualties

die within the first hour of severe wounding without advanced trauma life support... [and] 67 percent die within the first 30 minutes” [5]. Studies have shown that injured soldiers receiving medical care within the first hour have the greatest chance of survival and every minute after that hour their odds decrease significantly [5]. What these studies show is that time is of critical importance in treating a wounded soldier. Fortunately, today’s military members can rely on a robust and efficient evacuation system for casualties sustained on the battlefield [3], [5].

B. EXPLOSIVE ORDNANCE DISPOSAL

During the two recent major conflicts, Improvised Explosive Devices (IEDs) have become the preferred weapon of choice for insurgents to attack coalition forces. These devices can easily be made out of common everyday materials. It has become a constant struggle between coalition forces and insurgents. The insurgents make the devices harder to detect and coalition forces leverage technology and tactics to find IEDs before they can cause damage. Currently, coalition forces are winning the battle because they are discovering over 78% of IEDs before they detonate [6]. While discovering an IED is a small victory, the devices must be rendered safe by Explosive Ordnance Disposal (EOD). Because of the limited number of EOD teams, units must request their support through a standardized format for a team to come to the site of the IED for neutralization.

C. RAPID LOGISTICS REQUEST

Most battalion and higher level units develop a format for generic logistics requests and define the format in their unit standard operating procedures (SOPs). There are currently no Marine Corps standard formats for requesting logistics support, but most examples we researched had common elements. A rapid request format would typically include options for:

- Maintenance Contact
- Vehicle Recovery
- Resupply
- Troop/Cargo Movement
- Engineering Support

D. STRESSES IN COMBAT AND THE NEED FOR TAILORED INTERFACES

Stress is best described as interaction between three elements. “These elements consist of perceived demand, perceived ability to cope, and finally the perception of the ability to cope with the demand” [7]. It is well known that combat is stressful. However, the level of stress and how stress physically and mentally affects the soldier has only been scientifically studied over the last 60 years. Even with the best study, the conditions of combat can never fully be tested in an experiment or lab environment. Nevertheless the scientific experiments are able to shed light on what individuals face in combat and how soldiers react to the stresses of combat.

These studies have not found anything groundbreaking, as it is well known that stress decreases judgment and increases reaction time. The studies have been able to quantify how much stress affects humans both physically and mentally. Up to 80% of individuals in a stressful situations experience what is known as the tunneling effect or tunnel vision [8]. This effect makes the surrounding environment seem smaller and they are unable to process all of the stimulation for the environment. Next, over 80% of individuals have experienced time distortion whether it is slowing down or speeding up [8]. It has also been shown that in stressful conditions there is degradation in manual dexterity and fine motor skills [7]. Individuals lose their ability to write, hit a small button, or shake uncontrollably regardless of how scared they are [7], [8]. Furthermore, studies have shown that individuals’ “judgment in stressful situations is worse than when they are intoxicated or given powerful sedatives” [9]. Additionally, studies have found that factors like loud noise, sleep deprivation, fatigue, and poor nutrition levels can increase the negative effects of stress on the human body [7], [8]. One thing in common with all of these factors is that they will all be found in combat.

While the military may not have always quantifiably understood what stress does to a soldier, leaders have understood that stress does affect every soldier. Over the centuries, militaries have learned that a soldier can be inoculated against stress similar to diseases [10]. This inoculation includes introducing the soldier to stress during training [7], [8], [10]. This way the soldier can experience working under stressful conditions

before they experience stress in combat. This allows the soldier's body and mind to become stronger and more resistant to stress much like an individual trains their muscles in the gym [7]. Recent studies have shown that experienced soldiers are more resistant to the negative effects of stress than soldiers just entering the military [7–9]. Furthermore it has been shown through real-life situations and studies that simple tasks or well learned tasks can be completed and performed efficiently under stress [7], [9], [10]. This is why the unit leaders spend hours drilling their troops to perform simple tasks such as changing magazines and reaction to contact. Furthermore, the military has used this information when it comes to designing interfaces and procedures that are used in combat. Some may consider the military to be an expert in the realm of designing systems for use under stressful situations.

Even with the information from the studies and the knowledge on stress, the military is facing challenges with today's technology. Due to the fact that most systems are becoming more technology-based and have the ability to perform multiple functions, physical buttons and levers have started to disappear from system interfaces. The classic physical buttons and levers have disappeared even though they have been proven in studies to be easier to find and manipulate under stress [11]. Furthermore, the military is starting to get more COTS products instead of traditional purpose-built devices and systems. While this is not necessarily a bad thing, challenges arise when purchasing devices that were primarily designed for civilian use.

The primary challenge that COTS technology brings to the battlefield is how the soldier interfaces with the system. Lacking physical buttons or levers increases the likelihood of mistakes. Furthermore, the more options or modes the interface has, the more is the information overload [11], [12]. Systems that are not designed to be simple and easy to use run the risk of failing the soldier in a critical time of need. This has become more important today because it is believed that the soldier of the future will carry not only his rifle into battle but a smartphone as well. While undoubtedly smartphones, coupled with their applications, can increase lethality and effectiveness of a soldier, they also have the ability to become a burden. Their effectiveness, or burden, on

a soldier will be judged on the ease with which the soldier is able to interface with the system in a stressful situation.

While the technology industry has very good knowledge and experience in building interfaces for the normal user, it lags in the development of interfaces for users in a stressful situation [12]. On the other hand the military has an excellent understanding of stressful situations yet it lags behind in the understanding of technology. The development of a technology interface for stressful situations has undoubtedly lagged behind because of the small number of individuals that are affected and the lower potential for financial gain. With that being said, there are some researchers who have come up with seven guidelines or as they them “laws” that technology should adhere to when being used in a stressful situation, or what the researchers call High Velocity Human Factors (HVHF). They describe HVHF as a time-pressured, fast-evolving, and high-stakes environment [13]. A brief summary of the seven laws are provided below and a more detailed explanation for each can be found in Appendix F:

1. Law of Relevance

The human-machine interface (HMI) should help aid the user and provide helpful cues when appropriate [13].

2. Law of Acceptance [of Relevance]

The HMI should not be so overwhelming that it would contribute to the user losing situation awareness [13].

3. Law of Transparency

The HMI should not prevent the user from perceiving information from the surrounding environment [13].

4. Law of Clairvoyance

The HMI as the ability to predict information for the user or provide information before the user is aware they need it [13].

5. Law of Absoluteness

The HMI provides access to important information or functions with minimal buttons or key strokes, and can determine when approximations instead of exact numbers are more appropriate [13].

6. Law of Intelligence

The system should resolve as many choices as possible to eliminate work for the user and know the correct time to ask the user for inputs [13].

7. The Law of Reliance

The system does what it is intended to do with a trivial amount of false positives or negatives [13].

The seven laws described above are great guidelines that should be followed when designing an interface for future soldiers on the battlefield. If these laws are considered during the design of an application or device there is little doubt that the device or application will be able to meet the demands of a soldier on the battlefield in the 21st century. However, if these laws are ignored, lifesaving applications or devices could be considered too bulky or unrealistic on the modern battlefield or worse they will fail the soldier at the most critical time.

E. MEDICAL/CASUALTY EVACUATION FORMAT

The widespread use of radios during combat operations enables the front-line warfighters to request a variety of support. In most cases, requests for support have been standardized to streamline processing. Support can range from time sensitive requests, such as close air support, to routine resupply requests. Regardless of the request, the format is usually standardized across all branches of the military (as well as many NATO allies) to ensure all relevant information is passed in a timely, efficient and unambiguous manner; medical evacuations (MEDEVAC) or casualty evacuation (CASEVAC) requests are no different. In the U.S. military, there are two types of medical evacuations. While they have slightly different meanings, there is a difference that can confuse a layman.

Furthermore, the individual requesting the medical evacuation request only needs to submit the standard 9-Line format to receive support, because higher headquarters ultimately determines which of the two types of platform a unit will receive. The two types are CASEVAC and MEDEVAC. CASEVAC is the use of ground vehicles or aircraft to evacuate a casualty; the primary purpose of these vehicles is not medical evacuation but tactical support of troops on the ground. For example, a CH-53 (primarily a cargo transport) might be tasked to pick-up an injured Marine and take him to a medical treatment facility. A MEDEVAC is performed by a platform that has the sole purpose of medical evacuation. While there is a difference between CASEVAC and MEDEVAC, most individuals in the military use the terms interchangeably. Again, no matter which type of evacuation platforms one receives, the initial request is the same [14].

In order to have a casualty evacuated off the battlefield, an individual must send a MEDEVAC request to higher headquarters elements. From there, the higher headquarters make the appropriate decisions on what type of platform (ground or air) to deploy to evacuate the casualty in addition to which medical treatment facility is most suitable to deal with the injuries the casualty has sustained. Because time is critical during any evacuation, the request sent to higher headquarters must contain enough information to make an informed decision while not wasting time transmitting useless information.

The standard NATO MEDEVAC 9-Line request for all services is as follows:

Line 1–Location of Pickup Site

Line 2–Radio Frequency and Call Sign

Line 3–Number of Patients by Precedence

Line 4–Special Equipment Needed

Line 5–Number of Patients by Type

Line 6–Security of the Pickup Site

Line 7–Method of Marking for the Pickup Site

Line 8–Patients Nationality and Status

Line 9–Presence of Nuclear, Biological, or Chemical Contamination

Detailed descriptions are as follows.

1. Line 1: Location of Pickup Site

This line conveys the desired pickup location for the patient(s). This is normally within the proximity of the location where the casualty was injured. However, based on the situation, this location could be located several kilometers away from the where the injury was sustained. The on-scene commander normally determines this pickup location; however, depending on the platform used for the evacuation, the pilot may alter the pickup location because of platform limitations. The location of the pickup site must be sent in one of three formats:

- Military Grid Reference System (MGRS)
- Latitude and Longitude
- A previously designated Landing Zone (LZ).

In order to use a landing zone, the unit requesting the MEDEVAC must ensure that higher elements already have the coordinates to that landing zone. When passed over the radio, the radio operator will announce “Line 1” followed by one of the three approved formats. For example, “Line 1–11U GR 123 456” [14].

2. Line 2: Radio Frequency and Call Sign

This line is used to pass the radio frequency and call sign of the unit requesting the MEDEVAC so the platform performing the evacuation knows how and whom to contact on the radio. While this is important for any ground evacuation, it is extremely important for air evacuation. This information allows the helicopter to talk to the unit on the ground to receive terminal control before landing. In addition, this information is passed so that the higher elements that initially receive the request can reestablish communication if something happens during the transmission of the initial request. When passed over the radio, the radio operator will announce “Line 2” followed by the radio frequency and call sign. For example, “Line 2–F123, Wolverines” [14].

3. Line 3: Number of Patients by Precedence

This line is used to convey the number of patients that need to be evacuated and indicate how serious their injuries are. There are five different precedence levels that can be assigned to a casualty: urgent, urgent surgical, priority, routine, and convenience. Each level has an associated letter assigned to it. Letter “A” is assigned to urgent, “B” to urgent surgical, “C” to priority, “D” to routine, and “E” to convenience. The letters are used in place on saying the level over the radio to help speed up transmission and reduce errors. The senior medical individual on the scene (typically a medic, hospital corpsman or combat lifesaver) makes the determination of the level of precedence. This information is important in the sourcing of the appropriate platform(s) to handle the number of casualties and where to take the casualties after pickup [14].

Precedence Descriptions:

Urgent—the patient requires emergency, short notice evacuation within a maximum of two hours to save life, limb, or eyesight and to prevent serious complications of the injury, serious illness, or permanent disability.

Urgent Surgical—the patient requires forward resuscitative care for life and limb saving measures, and to attain stabilization for further evacuation.

Priority—the patient requires prompt medical care, within a maximum of four hours, to prevent the medical condition from deteriorating to an Urgent precedence level, to prevent unnecessary pain or disability, or who require treatment not available locally.

Routine—the patient who does not require immediate medical attention and whose condition are not expected to deteriorate significantly. They should be evacuated within 24 hours.

Convenience—a patient for whom evacuation by medical vehicle is a matter of medical convenience rather than necessity.

When passed over the radio the radio operator will announce “Line 3” followed by the letter for the precedence level and the number of patients. For example, “Line 3—A-3, B-1” [14].

4. Line 4: Special Equipment Needed

This line is used to request additional support for the patient that the requesting unit does not currently have. There are four responses for this line each associated with a letter code and multiple things can be requested by the unit. They are: A-None, B-Hoist, C-Extraction Equipment (jungle/forest penetrator, etc.), and D-Ventilator. Upon requesting additional equipment the evacuation platform will load the equipment and have it available for the requesting unit at to the pickup site when they arrive. When passed over the radio the radio operator will announce “Line 4” followed by a letter or letters. For example, “Line 4–A” [14].

5. Line 5: Number of Patients by Type

This line is used to ensure the platforms sent to retrieve the casualties are correctly configured. There are two categories for this line, ambulatory or litter. The determination of category is made by the senior medical representative on-scene. An ambulatory patient can move under his or her own power and their injuries do not prevent them from walking. A litter patient is a patient who cannot move under his or her own power or their injury prevents them from doing so, thus requiring a litter to be moved. To save time, a letter is associated with each type with “A” representing ambulatory and “L” representing litter. Also, the total number in this line must match the total number of patients reported earlier in Line 3. When passed over the radio, the radio operator will announce “Line 5” followed by a letter with a number. For example, “Line 5–A-8, L-2” [14].

6. Line 6: Security at Pickup Site

This line is used to provide situational awareness for the pilots and determine if the evacuation platform is going to need assistance from escorts. Since medical vehicles cannot be armed, they may need an armed escort to protect them as they approach the pickup site and during the evacuation. The unit leader ultimately determines the security of the pickup site and they have four options from which to choose. For brevity purposes the choices are associated letter with a particular. The first is “No enemy troops in the area” and is represented by “N.” Next is “Possible enemy troops in the area (approach

with caution)” and is represented by “P.” This is used when the unit is unsure if enemy troops are in the local area. Next is “Enemy troops in the area (approach with caution)” and is represented by “E.” This is used when the enemy is known to be in the area but only presents a minor threat. The final option is “Enemy troops in the area (armed escort required)” and is represented by “X.” This option means there are enemy troops in the area that present a significant threat. When passed over the radio the radio operator will announce “Line 6” followed by a letter with a number. For example, “Line 6–E” [14].

7. Line 7: Method of Marking Pickup Site

This line is used to assist the evacuation unit in finding the exact location of the pickup site as they approach. This is primarily used in air evacuation but can also be used to assist ground evacuation. The unit leader makes the decision on how to mark the pickup site based on the situation and materials at his disposal. There are five options, four of which are default selections. The unit commander can select panels, pyrotechnic signals, smoke signals, none, or other. Each option is given a letter for brevity: “A” for panel, “B” for pyrotechnic signals, “C” for smoke signals, “D” for none, and “E” for other. If the option of “other” is chosen, the unit leader needs to indicate what the method will be. For example, if an infrared buzz saw was selected, the radio operator would pass “E–infrared buzz saw.” The color of the smoke or panels is never passed during transmission. This is for security reasons, as the pilot will identify the smoke color upon visual acquisition. He will indicate over the radio “I see red smoke” or something similar, and the unit leader will affirm to the pilot that he has acquired the correct mark. This is done to prevent the enemy trying to lure in the evacuation unit to a false LZ. When passed over the radio the radio operator will announce “Line 7” followed by a letter. For example, “Line 7–C” [14].

8. Line 8: Patient(s) Nationality and Status

This line is used to help determine the destination of the injured patient and if a guard or translator is required. Similar to Line 5, Line 8’s total must match the count in Line 3. To speed up transmission, each option is associated with a letter. The options are self-explanatory and are as follows: A-United States Military, B-United States Civilian,

C- Non-United States Military, D- Non-United States Civilian, and E-Enemy Prisoner of War. When passed over the radio the radio operator will announce “Line 8” followed by a letter with a number. For example, “Line 8–C–8” [14].

9. Line 9: Nuclear, Biological and Chemical Contamination

This line is used to determine the location the evacuation unit is to deliver the patients and determine the Mission Oriented Protective Posture (MOPP) level of the evacuation unit. If a patient is contaminated, they should not be delivered to a facility that is not contaminated or do not have the resources to deal with a contaminated patient. There are four options for this line with associated letters for brevity. They are as follows N-Nuclear, B-Biological, C-Chemical, and None. If “None” is selected, the individual simply announces “None” over the radio. When passed over the radio, the radio operator will announce “Line 9” followed by a letter or “None.” For example, “Line 9–None” [14].

F. MEDEVAC/CASEVAC PROCESSING

A complete MEDEVAC 9-Line would be transmitted over the radio as follows.

“Eagle this is Wolverine stand by for MEDEVAC request, break.”

“Line 1–11U GS 123 456, break.”

“Line 2–F123, Wolverine, break.”

“Line 3–A-3, C-1, break.”

“Line 4–A, break.”

“Line 5–L-3, A-1, break.”

“Line 6- P, break.”

“Line 7–C, break.”

“Line 8–A-3, B-1, break.”

“Line 9–None, over.”

Following this transmission, the unit that received the MEDEVAC request will read the request back to the requesting unit to ensure all information was correctly received.

A MEDEVAC 9-Line is generated in one of two ways on today's battlefield. The individual that creates the MEDEVAC request typically references a 9-Line template and writes the information out on a separate piece of paper. Alternatively, the individual might have a laminated MEDEVAC 9-Line template that they circle and fill in the blanks using a map pen. Either way, the user is required to write the information down before sending the information up to higher headquarters because of the length and particular format required. Due to the complexity and importance of the task, one member of the unit is usually assigned the primary responsibility of the generating and passing the information up to higher elements. In addition, there is always at least an alternate and more than likely multiple individuals assigned this task in case the primary individual is the casualty. The experience level of these individuals with MEDEVAC requests is based off of the size of the unit and the amount of training on MEDEVAC these individuals have received. In most conventional units, the top five leadership positions typically have the most experience on MEDEVAC 9-Line requests; the remaining members of the unit will likely have little to no training. The most experienced members are the Platoon Commander, Platoon Sergeant, and the three squad leaders. While all these individuals normally have the most exposure to the MEDEVAC 9-Line format, usually only the Platoon Commander and Platoon Sergeant have been extensively trained or have real-life experience on MEDEVAC procedures. This creates issues when units operate smaller than platoon size elements, which has become more normal over the last decade of war. To help eliminate this issue, some units require the squads to send their MEDEVAC requests to the platoon first and the Platoon Sergeant ensures the request is in the proper format before passing the request to higher themselves, even if the squad is able to communicate with higher from their current position. Obviously, this creates an additional layer that increases the time and chances of errors while the squad could have requested MEDEVAC directly.

After the individual generating the request has all required information, the request is transmitted to higher elements. This is typically accomplished over a radio net. Upon receiving the request the receiving will read back the request to verify all information is correct. The information is then entered into a tactical chat window on a computer that is monitored by all units in theater. If a receiving unit lacks a computer to enter the request into the chat window, the request is passed via radio to the next level until it reaches a unit with the proper equipment. From there, the request continues to travel up the chain of command until it has reached the appropriate level to make the decision on what type of resources can be dedicate to the MEDEVAC request. Currently, this is usually at the division watch officer level. After the platform decision has been made, the requesting unit and the evacuation unit are notified of the decision and passed all relevant information.

G. EXPLOSIVE ORDNANCE DISPOSAL FORMAT

The standard UXO/IED Spot Report for all services is as follows: [15]

Line 1–Date-Time-Group when the device was discovered

Line 2–Unit Identification and location of IED/UXO

Line 3–Contact Method

Line 4–Type of Ordnance

Line 5–CBRNE Contamination

Line 6–Resources threatened

Line 7–Impact on Mission

Line 8–Protective Measures

Line 9–Recommended Priority

Detailed descriptions of the individual lines are as follows.

1. Line 1: Date-Time-Group

This line is used to inform EOD team, or higher headquarters, when the device was discovered. The standard time date-time-group is DDHHMM(Z)MONYY. When passed over the radio, the radio operator will announce “Line 1” followed by the date-time-group. For example, “Line 1- 070759JUN14” [15].

2. Line 2: Unit Identification and Location

This line is used to inform which unit discovered the device and the approximate location of the device. The location of the IED is passed using 8 digit MGRS which gives a precision of 10 meters. While getting the most accurate location of the IED is important, it is not worth risking the life of an individual, so most of the time the location is estimated as accurately as possible. When passed over the radio, the radio operator will announce “Line 2” followed by the unit identification and IED location. For example, “Line 2- 1st LAR, Bravo Company, 1st Platoon, 11U GR 1234 5678” [15].

3. Line 3: Contact Method

This line is used to pass the radio frequency and call sign of the unit requesting EOD support. This allows the EOD teams to directly contact the unit in case there is need for more information or most likely to establish a link-up point with the ground unit to guide the EOD team to the device. While radio frequency and call sign is the most common, one could pass a point of contact and a telephone depending on the location of the IED. When passed over the radio, the radio operator will announce “Line 3” followed by the radio frequency and call sign. For example, “Line 2–F123, Wolverines” [15].

4. Line 4: Type of Ordnance

This line is used to announce the number and type(s) of ordnance that has been found. The categories for these are projected (fired from a surface weapon), dropped (fired from an aviation platform), placed (put on the ground), thrown (such as a hand grenade), or possible IED. When passed over the radio the radio operator will announce “Line 4” followed by the number(s) and type(s). For example “Line 4–1 Dropped, 2 Projected” [15].

5. Line 5: CBRNE Contamination

This line is used to inform the EOD teams, or high headquarter, if the device appears to be a chemical, biological, radiological, or a nuclear device. This informs the EOD teams if they need to bring special protective equipment to the site. When passed

over the radio, the radio operator will announce “Line 5” followed by the CBRNE contamination. For example, “Line 5–None” [15].

6. Line 6: Resources Threatened

This line is used to report what assets are threatened by the IED or UXO. This information is used in conjunction the several of the other lines to determine the response of the EOD team by higher headquarters. Because the teams are in limited supply, higher headquarters use this information to determine which requests to respond to first by prioritizing the requests that have the most impact on the mission or threat to resources. Resources could include, but are not limited to equipment, facilities, civilian infrastructure, etc. When passed over the radio, the radio operator will announce “Line 6” followed by the resources that are threatened. For example, “Line 6–local school 20 meters to the Northeast” [15].

7. Line 7: Impact on Mission

This line is used to help inform the EOD teams and high headquarter what the tactical situation the unit is facing that discovered the device. This line should be as short and concise as possible but provide enough information for the high headquarters to determine the priority of removing the device. When passed over the radio, the radio operator will announce “Line 7” followed by the impact of the mission. For example “Line 7–currently taking small fires and can’t move around the IED” [15].

8. Line 8: Protective Measure

This line is used to determine the appropriate level of protection/escorts needed by the EOD team. Protective measures can range from establishing a complete cordon to nothing at all depending on the local situation. When passed over the radio, the radio operator will announce “Line 8” followed by the protective measures taken. For example, “Line 8–200 meter cordon around the device in addition to an over watch of the surrounding area” [15].

9. Line 9: Recommend Priority

This line is used to relay the unit commander's opinion on the priority of response. The unit commander can choose from one or four options. They are as follows:

Immediate—stops the unit's maneuver and mission capability, or threatens critical assets vital to the mission

Indirect—slows the unit's maneuver and mission capability, or threatens critical assets important to the mission

Minor—reduces the unit's maneuver and mission capability, or threatens noncritical assets of value

No Threat—has little or no effect on the unit's capabilities or assets

While temping, unit commanders must resist inflating the priority the IED has on their current mission. When passed over the radio, the radio operator will announce "Line 9" followed by the unit's recommend priority. For example, "Line 9– Indirect" [15].

H. EXPLOSIVE ORDNANCE DISPOSAL REQUEST PROCESSING

A complete EOD 9-Line would be transmitted over the radio as follows.

"Eagle this is Dragon stand by for EOD 9-Line request, break."

"Line 1–271800ZMAY14, break."

"Line 2–A 1/1, 18S TU 135 485, break

"Line 3–LCpl Smith, Frequency F123, Callsign Dragon, break."

"Line 4–1 Possible IED, partially buried container with exposed wires, break."

"Line 5–None, break."

"Line 6–Device near local commerce center, break."

"Line 7–Patrol halted, break."

"Line 8–Dismounts deployed providing cordon, 5s and 25s conducted, break."

"Line 9–Indirect, break."

Following this transmission, the unit that received the EOD request will read the request back to the requesting unit to ensure all information was correctly received. The request will then be routed to the supporting EOD unit for prosecution.

I. RAPID LOGISTICS REQUEST FORMAT

For application development, we took the common elements of the rapid logistics request formats we researched and combined them into a common format. The first four lines are required, and lines 5–9 are optional depending on the type of request. The request format is as follows:

1. Line 1: Unit Name/POC

This line is to inform the supporting agency for with whom coordination will occur. Information provided in this line includes a POC name, Unit Name, and Frequency/NetID.

2. Line 2: Precedence

This line captures the relative necessity of the request. The options include routine (support needed within 72 hours), priority (support needed within 24 hours), and emergency (support needed as soon as possible).

3. Line 3: Type of Request

This line indicates what type of support the user is requesting. Options include:

- Resupply–Used to indicate that the user needs a resupply of some kind.
- Maintenance–Used to indicate that the user needs support from higher echelon maintenance personnel.
- Vehicle Recovery–Used to indicate that the user needs assistance recovering a disabled vehicle.
- Engineer Support–Used to indicate that the user needs assistance from supporting engineer personnel.
- Pax/Cargo Movement–Used to indicate that the user needs assistance from higher headquarters to move personnel or equipment.

4. Line 4: Coordinating Instructions

This line is used to provide the location of the request along with the desired time (as soon as possible or a particular time). Additionally, the user can provide any amplifying information that is specific to the situation but not included anywhere else on the request format.

5. Line 5: Resupply

This line is populated if line 3 indicated that the user wanted resupply support. The user can select the class of supply needed (I, II, III, IV, V, VIII, and IX) and provide a description/quantity of what is needed.

6. Line 6: Maintenance Contact

This line is populated if line 3 indicated that the user wanted maintenance contact support. The user will input the nomenclature of the equipment needing repair along with a description of the problem.

7. Line 7: Vehicle Recovery

This line is populated if line 3 indicated that the user needs vehicle recovery support. The user will input the nomenclature of the vehicle along with a description of the problem.

8. Line 8: Engineer Support

This line is populated if line 3 indicated that the user needs engineering support. The user can select from the following options:

- Mobility—Used when the user needs obstacle reduction and/or to maintain freedom of movement by maneuver units.
- Countermobility—Used when the user needs engineering support to construct obstacles to delay, disrupt and destroy the enemy by reinforcement of terrain.
- Survivability—Used to indicate that the user needs engineering assistance to construct/reinforce facilities to protect personnel and equipment.
- Horizontal Construction—Used to indicate that the user needs engineering assistance to shape the terrain to meet the operational requirements of the

unit. This includes route construction, expeditionary airfields, and site preparations.

- Vertical Construction–Used to indicate that the user needs engineering support to construct expeditionary fortifications, camps, and maintenance facilities.
- Other–This is used to indicate that the user needs engineering support that is not included above.

Line 8 also includes a section to provide a brief description of the support needed by the unit.

9. Line 9: Pax/Cargo Movement

This line is populated in line 3 indicated that the user needs movement support. There are options to indicate a number of personnel, cargo weight/description and a destination location.

J. RAPID LOGISTICS REQUEST PROCESSING

A rapid logistics request will only include lines 1–4 and whatever lines are indicated by line 3 (request type). An example request for resupply would be:

“Eagle, this is Dragon, stand by for Rapid Logistics Request, break.”

“Line 1: POC Lance Corporal Smith, A 1/1, Frequency F123, break”

“Line 2: Routine, break”

“Line 3: Resupply, break”

“Line 4: ASAP, 18S TU 135 485, break”

“Line 5: Class I–3 DOS Chow and Water for 12 Marines, break”

“Line 6, 7, 8, 9 Not Entered, Break”

Following this transmission, the unit that received the rapid logistics request will read the request back to the requesting unit to ensure all information was correctly received. The request will then be routed to appropriate section/unit for prosecution.

K. CURRENT CHALLENGES IN TRAINING

Based on the current political and economic climate, the Department of Defense (DoD) is likely to face a constrained budget for the foreseeable future. However, this is nothing new to the military because over the last sixty years the DoD has had to deal with a cycle of booms and busts. Since World War II to present, the DoD has had to face extreme cuts after every conflict. In addition, over the last sixty years, they have seen their budget steadily reduce as a percentage of Gross Domestic Product from nearly 40% during World War II to a projected 3.6% in 2015 and from nearly 70% of the Federal Budget in the 1950s to a projected 15.6% in 2015 [16]. The constant cycle of boom and bust along with a steadily decreasing budget relative to the Federal Budget leads to challenges by itself. Furthermore, to complicate matters, the number of missions the Department of Defense is responsible for has steadily expanded over the years, especially in the last decade [16]. No longer is the military solely responsible to fighting conventional conflicts, but must now shoulder the responsibility of humanitarian assistance/ disaster relief (HA/DR), national building, and counter-terrorism. The issues of limited money and time do not appear to be persistent, especially with the challenges of the growing cost of military member compensation and the dynamic nature world events.

While the budget by itself is an issue, wartime provides many additional challenges. Over the last decade of constant combat operations, operational forces within the military have faced many challenges. The main challenge they have had to face is the rigorous deployment cycle. At the height of combat operations some units faced a one-to-one ratio of days deployed to days stateside [17]. While commanders always face the challenge of limited funds to conduct training, the operational tempo has compounded the challenges of training their units for upcoming deployment. Like most individuals they prioritized their goals and focused on accomplishing their top-level goals before deployment; however, this naturally leads to units and individuals doing very well at a particular task but they lacked breadth across all functional areas.

The Marine Corps is no different from any other service when it comes to dealing with the challenges of limited time and money; we, as a service, have to prioritize time

and money. In the realm of medical evacuation request, recruits in Boot Camp currently do not receive any formal training on MEDEVAC request, EOD request in their initial training. After boot camp, when young Marines start formal training for their military occupational specialty, there is some advanced medical training. For young Marines going into the infantry, they only receive an additional 6.5 hours of medical training, 3.5 hours of how to identify an IED but receive no formal training dealing with medical evacuation requests or EOD requests in over 300 hours of instruction at the School of Infantry [18]. Individuals not going to the infantry receive only 4.25 hours of advanced medical training, and IED training, and like their infantry brethren; they do not receive any training on medical evacuation requests or EOD requests [19]. Progressing in rank does not increase the chances of receiving formal MEDEVAC request training or EOD request until a deployment is on the horizon.

The next formal school most infantry Marines attend in their career is Infantry Small Unit Leaders Course, which is a Professional Military Education (PME) requirement. The course is targeted for Sergeants serving as squad leader or section leaders. Even this school, whose purpose is to “develop the leadership, decision-making capability, and proficiency of infantry Sergeants...and procedural proficiency of small unit leaders,” does not give a formal class on medical evacuation or EOD request procedures to the students [20]. The Marines are expected to have acquired the knowledge before starting the school [20]. The issue with this is that these are the Marines who will lead 12 to 15 personnel in foreign countries without an Officer or Staff NCO present and may face the challenges of having to call in a MEDEVAC or EOD 9-Line request while under fire. While most will obtain this knowledge through self-studying and their leadership as they grow, there is no guarantee this will happen. If the training does occur, there is no guarantee that the training knowledge will be retained by the Marine over a long period of time, especially if they have been practicing it.

With the current training standards, Marines could potentially serve in the Marine Corps for eight years without any type of training on a MEDEVAC 9-Line request or EOD requests. The main issue is that the Marine Corps relies on the infantry battalions to train their junior Marines and young leaders on requests of this nature. However, infantry

battalions are constrained by limited resources (time, money, and training aids) compared to formal schools within the Marine Corps. While unit leaders in the infantry battalions can provide informal classes on MEDEVAC 9-Line request or EOD requests to all experience levels, they typically lack the ability to evaluate the Marines properly. Because of these time constraints normally only the top five leadership positions in the platoon get detailed in-depth training on MEDEVAC 9-Line requests or EOD requests and two are the Platoon Commander and Platoon Sergeant. In addition, these individuals are evaluated on a regular basis. Their evaluations are performed informally through company staff during company training events and formally by outside staff during Enhanced Mojave Viper. This creates a critical vulnerability of having valuable knowledge concentrated into the hands of a select few. With 83.5% of the current active duty enlisted Marines being a Sergeant or below, this can become a major problem in combat since one does not get to pick when a casualty will happen or who will be present to call in the MEDEVAC 9-Line request or an EOD request [21].

L. WHY SMARTPHONES AND ANDROID

Currently in the United States, over 60% of mobile phone users use a smartphone, which is an increase of over 10% from last year [22]. In the last decade, smartphones have taken over 50% of the market share of the mobile phones sold worldwide [23]. In the first three quarters alone of 2013, over 261.1 million smartphones were shipped to end users around the world, which was up over 45% from the year before [23], [24]. Smartphones offer the variety of functions and sensors in the palm of user's hand. They include: accelerometer, gyroscope, compass, GPS, Wi-Fi, camera, telephony, and processing power that rivals supercomputer of the early 1980s. Furthermore, while smartphones increase in processing power, features, and functions every year, they are also becoming more affordable. Many experts believe for a number of tasks they could replace the personal computer in the near future.

While there is no doubt that smartphone is a valuable piece of technology that is being leveraged by the commercial sector, the military has yet to fully embrace the use of smartphones. The military is not against the use of smartphones on the battlefield, but

there is a need to solve several challenges the commercial sector does have to worry about. The two primary issues are connectivity and security. The number one reason why smartphones have not seen wide spread use in the military is the lack of connectivity on the battlefield or at sea. Luckily, in the past few years, there have been numerous technology advances that seem feasible for use in the military domain. They range from middle orbit satellites to microwave base networks for naval ships, which would give ship a 4G LTE network. Both of these technologies have been tested and are still under development [25], [26].

There is currently little doubt in the military that smartphones could be leveraged on the battlefield to increase lethality and effectiveness. Some day in the not too distant future, soldiers will carry a smartphone into battle along with their rifle [27]. Besides many other questions, this brings up the question on operating systems: which is the best operating system for the military use?

Based on the National Security Agency's (NSA) approval of a secure version of Android Operating system for use in the military on networks in 2013, we decided that the Android Operating system was ideal for the testing our application [28]. Finally, the National Security Agency is currently in the process of approving the Android Operating system for approved use in the military domain for use on secret networks [28].

M. CURRENT APPLICATIONS ON THE MARKET

We found four applications on Google Play that deal with a MEDEVAC 9-Line request they are: *Basic 9 Line MEDEVAC*, *9-Line MEDEVAC*, *Army Reports*, *Army Leader Smart Cards* [29]. One of these applications (*Army Leader Smart Cards*), which is more of a reference, provides the user with a report format for the MEDEVAC 9-Line request with a brief description of what belongs in each line, as well as formats for several other important reports in the military. The other three applications allow the user to input information to fill out a MEDEVAC 9-Line request. One application (*9-Line MEDEVAC*) is self-described as a “learning tool” to help the user practice completing the MEDEVAC 9-Line request. The last two applications (*Basic 9 Line MEDEVAC* and *ARMY Reports*) appear to be intended for use in a field environment. One allows the user

to send information via text message and the other provides a radio transmission template to send via the radio after the user inputs information needed for a MEDEVAC 9-Line request. However, there are several flaws with these two applications if field use is their goal. First, the applications did not take in consideration the stress the user would be under in trying to fill out the form. Both applications lack many basic and important time saving features. *Basic 9 Line MEDEVAC* does not allow the user to save information for later use. *Army Reports* lacks a helpful hints feature for inexperienced users, and both of the user interfaces are not optimized for a user under stressful conditions. The next issue is that only one application allows the user to send the information to someone else. However, this is by text message or e-mail and provides the user with no means of informing them if the message was received. In addition, security is an issue because all MEDEVAC 9-Line requests are required to be encrypted, but these methods of delivery are not encrypted. Finally, none of these applications have Department of Defense approval, which again leads to the issue of security and approved use on the battlefield.

Like the MEDEVAC application we found applications that are available on Google Play for download, but there were only two applications that cover IED/UXO reports. The first was *Army Leader Smart Cards*, which also contains information about MEDEVAC, but this application is only a reference that shows the user the report format. [30] The application gives a brief description of what belongs in each line but does not allow the user to enter any information. The other application, *Basic 9 Line UXO-IED*, is a self-described training application [30]. This application gives the user the opportunity to enter information for each line and e-mail the report to a superior for review.

The challenges that face the Marines Corps in getting the proper training to the correct individuals is vast with the constraints of time and money, and because of this minor but important training is given little to no time at all in the training schedule or only to a select few. Many important requests (MEDEVAC, EOD, Rapid Logistics Request) fall into this category and to compound matters these requests are required to be submitted into a precise format, which is difficult to accomplish by an individual who lacks the appropriate training in a stressful environment. To help alleviate this potentially dangerous and deadly situation smartphones with applications tailored to a particular

request can be leveraged to reduce the chances that a situation would happen in the future. With COTS smartphones with application specific requests the Marine Corps could achieve a better result in the training of all individuals on requests with no more time that is currently being used and achieve a better result. However, for this to work the application must be specifically tailored for use in a stressful environment to eliminate errors and help the user with the request as much as possible and in the next chapter the design of three applications for MEDEVAC, EOD, and Rapid Logistics Request will be examined.

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III. DESIGN

A. SYSTEM DESCRIPTION

HELP is intended to provide an application suite for warfighters in an operational environment to call for resources from supporting headquarters [1]. It walks the user through several standard formats for calling resources, such as medical/casualty evacuation (MEDEVAC/CASEVAC), rapid logistics request and EOD support. The application suite operates on a smart device capable of running the Android operating system, and utilizes inherent sensors built into the device. The smart device likely be a smart phone or a tablet, which is compact enough for an infantryman to carry while conducting dismounted operations.

From a design perspective, HELP needs to be simple enough so that a Marine with little to no prior experience with standardized message formats can submit a request for support with all required information in a timely manner [1]. To begin, the Marine simply opens the proper application corresponding to his needs (MEDEVAC/CASEVAC, Rapid Logistics Request, EOD Request) and inputs the required information.

B. CONCEPTUAL DESIGN

The overall system architecture consists of three parts: a mobile client, communications network, and workstation [1]. The mobile client takes information and input from user in order to generate a properly formatted request. The request is then either transmitted via voice radio or digital network connectivity to the user's higher headquarters COC. Finally, the watch officer at the receiving headquarters will input the information into Tactical Chat (TacChat) by either manually entering the information (from a voice radio transmission) or copying and pasting the information (from a digital transmission).

The mobile client is designed for use on an Android device. The client suite has been implemented in native Android code utilizing the Android Software Development Kit (SDK). A Java-based desktop system acting as a server is required for connectivity and digital data transmission. Due to the varying message formats of the three sample

requests (MEDEVAC/ CASEVAC, Rapid Logistics Request, EOD Request), we have created three separate applications, one for each type of request. HELP is likely to be used in austere environments; as such, the conceptual design is for a ruggedized smart phone. We have developed and tested HELP on a commercially available Samsung Galaxy Nexus (see Figure 1 for dimensions).



Figure 1. Samsung Galaxy Nexus Dimensions, from [31]

The decision to develop the application using native Android was swayed by the open-source nature of the operating system coupled with the wide variety of development tools available for use. Additionally, any smart devices running Android generally has several sensors and capabilities available for the system to draw from. The capabilities we are interested in exploiting are the global positioning system (GPS) capability, camera, internal database storage, and WI-FI capability. These assist the user populate the necessary information for the request to be transmitted and acted upon by their higher headquarters.

A working prototype of the HELP suite has been developed during this thesis. The remainder of this section captures the key screens and provides a description of functionality. Each application utilizes a welcome screen and a swipe navigation scheme to guide the user through the lines. The final screen is the properly formatted call for resources that the user can either call over the radio or transmit digitally, if network connectivity is available.

C. COMMON FEATURES

The three applications that make up the HELP suite have several features that are common to them. These include:

1. Swipe Navigation

HELP primarily uses swipe navigation to enable users navigate from line to line of their request. To make the user interface simple, we wanted to separate each line (of the 9 line format) on a separate screen and enable the user to transition from one line to the next. For such transitions, swiping is the most natural gesture for touch sensitive devices.

2. Haptic Feedback

The HELP suite uses the device's built-in vibration capability to provide haptic feedback to the user in order to provide a tactile response when the user enters an input. Vibration feedback, combined with visual feedback, greatly assists the user input the required information during a stressful scenario.

3. Color Indicators

We use a red/green color schematic to provide visual feedback to the user when he provides input. Prior to any entry by the user, the bottom of the screen is red to indicate that the required fields have not been populated. Upon correct entry of the required information, the color changes to green to indicate that the user may advance to the next screen.

4. Definition Windows

We designed HELP to be used by Marines with little to no experience. To make it easy, all of the applications in HELP are designed to display definitions to the user when needed. If the user is unfamiliar with a given term, he may simply touch the term and a definition display pops up.

5. Line Generation

All three of the requests used in our application suite have specified formats that must be followed in order for the supporting headquarters to provide timely support. All of the applications take the user's input and translate it to the required format for use by any supporting headquarters.

6. Transmission Control Protocol

When available, all of the applications use simple transmission control protocol (TCP) connectivity to allow for speedy transmission of the request to a supporting headquarters.

D. NETWORK CONNECTIVITY

All of the HELP applications provide connectivity to the individual Marines' higher headquarters through a TCP connection. Currently, the server is a simple terminal program that listens for incoming connections from users. The main goal for network connectivity is to reduce the transmission time and eliminate errors that can occur when reporting data by over the voice radio. The communications chain is as follows and is depicted in Figure 2.

1. Smart Device to Radio

In this stage, the smart device has two options to connect to a radio. One method is wirelessly, using the radio as a WI-FI hotspot. This connection can be secured through a variety of means; for our testing we used WPA2 encryption. The second option is to connect the Android device to the radio via a connection cable. The radio we used during

testing and development was a Persistent Systems Wave Relay Man Portable Unit Gen 4.¹

2. Radio to Radio

In this stage, the unit's radio is communicating with the distant end radio at the unit's COC via VHF transmission. The Persistent Systems Radio is capable of encrypting this transmission in a variety of methods. For our testing, we used 256 bit AES-CTR with HMAC-SHA 512 (Suite B) encryption.

3. Radio to Workstation

The radio at the COC is connected to the workstation via an Ethernet cable. The formatted request is displayed on the workstation terminal.

4. Tactical Chat

Upon receipt of the request from the HELP client, the COC watch can copy the request and paste it into the appropriate Tactical Chat (TacChat) window for prosecution. For example, a CASEVAC request would be posted to the theater/AO MEDEVAC/CASEVAC chat window.

¹ Product can be seen at <http://www.persistentsystems.com/man-portable-unit-gen4/>

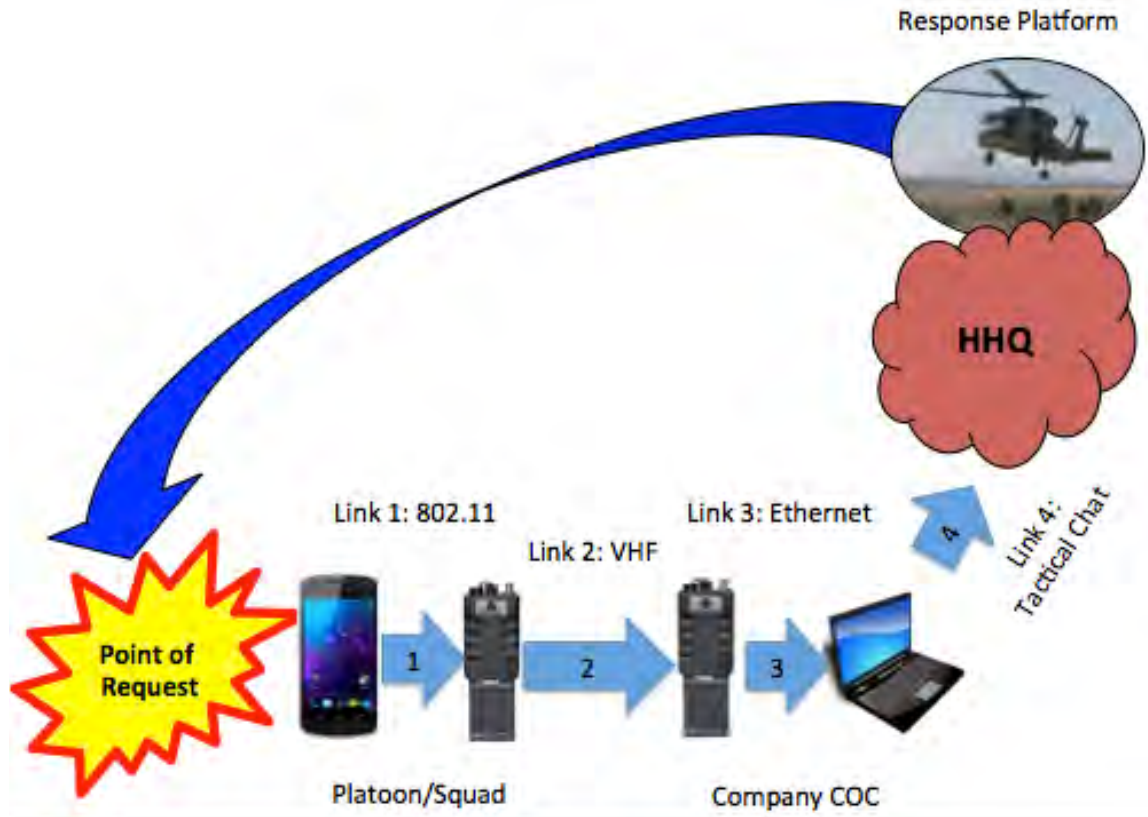


Figure 2. HELP Digital Communications Chain

E. APPLICATION DESCRIPTIONS

The following section outlines all of the HELP design and functionality. Each screen description is followed by a figure depicting a new screen with numbered arrows corresponding to the outline description. A second figure depicting a screen resulting from user input follows the first figure.

1. HELP Settings Application

The HELP Settings application is the central application to the HELP Suite. All other applications pull information from the HELP Settings application to auto-populate fields in other applications for their respected request [1]. This application is populated prior to departure on any mission.

a. Settings Screen

Below is a list of the features and information requiring entry into the HELP Settings application. A screenshot of both prior to data entry and after data entry is included at the end of this section.

(1) **Navigation Bar.** This assists the user by indicating what screen the user is currently on. All application settings are entered on this one screen.

(2) **Current Unit ID.** This is the current Unit Identifier that is currently saved in the system. If nothing is entered, the text “Not Entered” is displayed in red. Upon entering data, the text changes to black.

(3) **Update Unit ID Button.** This is a button with an EditText² field to the right. When the user inputs his unit identifier (i.e., 1st Platoon, A 1/1) and presses the Update button, the data is stored in the settings SQLite database.

(4) **Current Frequency/Net ID.** This is the current frequency/net ID that is currently saved in the system. If nothing is entered, the text “Not Entered” is displayed in red. Upon entering data, the text changes to black.

(5) **Update Frequency/Net ID Button.** This is a button with an EditText field to the right. When the user inputs his frequency/Net ID (i.e., F123 or 12.120) and presses the Update button, the data is stored in the settings database.

(6) **Current Callsign.** This is the current callsign that is currently saved in the system. If nothing is entered, the text “Not Entered” is displayed in red. Upon entering data, the text changes to black.

(7) **Update Callsign Button.** This is a button with an EditText field to the right. When the user inputs his callsign and presses the Update button, the data is stored in the settings database.

(8) **Current Higher Headquarters IP Address.** This is the current higher headquarters IP address that is currently saved in the system. If nothing is entered, the text “Not Entered” is displayed in red. Upon entering data, the text changes to black.

² EditText: This is an Android widget that allows the user of a system to type in a text input.

(9) **Update Higher Headquarters IP Address Button.** This is a button with an EditText field to the right. When the user inputs his higher headquarters' IP address and presses the Update button, the data is stored in the settings database.

(10) **Current Higher Headquarters Port.** This is the current higher headquarters port that is currently saved in the system. If nothing is entered, the text "Not Entered" is displayed in red. Upon entering data, the text changes to black.

(11) **Update Higher Headquarters Port Button.** This is a button with an EditText field to the right. When the user inputs his higher headquarters' port and presses the Update button, the data is stored in the settings database.

(12) **Test Connection Button.** This button tests connectivity with the higher headquarters server based upon the current IP address and port. A Toast³ indicates a successful connection.

(13) **Clear Settings Button.** This button clears all of the current settings and set them to "Not Entered."

³ Toast: This is an Android widget that displays a pop-up warning to the user with text. Throughout this application, a Toast indicates a warning.

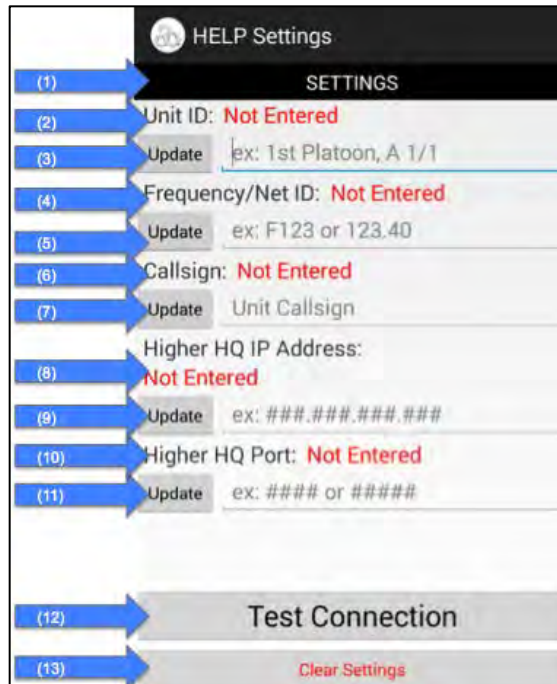


Figure 3. HELP Settings Prior to User Input



Figure 4. HELP Settings After User Input

2. CASEVAC Application

The CASEVAC application is intended to help generate a MEDEVAC request. In this section, each screen in the application is explained in depth.

a. Welcome Screen

The purpose of this screen is to inform the user about the basic functionality of our application. The screen describes how to reach the settings application, how to navigate to the different lines, and how to display the definitions of unfamiliar terms.



Figure 5. CASEVAC Welcome Screen

b. Line 1: Landing Zone Location

The purpose of line 1 is to indicate where a rotary-wing aircraft can land in order to transport the injured Marine. The screen breaks down the line into the following areas:

- (1) **Navigation Bar.** This assists the user by indicating what line he is currently on.
- (2) **Line Title.** Indicates the title of the line.

(3) **Use GPS Button.** This button calls the system's GPS to populate the current latitude and longitude. The latitude and longitude is used to create the line 1 information.

(4) **Latitude EditText Box.** This allows the user to manually enter the desired pickup site latitude.

(5) **Longitude EditText Box.** This allows the user to manually enter the desired pickup site longitude.

(6) **Use Manual Lat/Long Button.** Once the user populates the latitude and longitude, this button creates line 1 using the input information. If the latitude or longitude is blank, the system displays a warning to the user via a Toast.

(7) **MGRS EditText Box.** This allows the user to manually enter the desired pickup site Military Grid Reference System grid.

(8) **Use Manual MGRS Button.** Once the user populates the MGRS grid, this button creates line 1 using the input information. If the MGRS EditText box is blank, the system provides a warning via a Toast.

(9) **Line 1 Preview.** Initially this has a red background to indicate to the user that he is not done completing the necessary information. Upon populating the GPS lat/long or manual entry of coordinates, the background color changes to green and line information populates, indicating that the user is ready to move to the next line.



Figure 6. CASEVAC Line 1 Prior to User Input

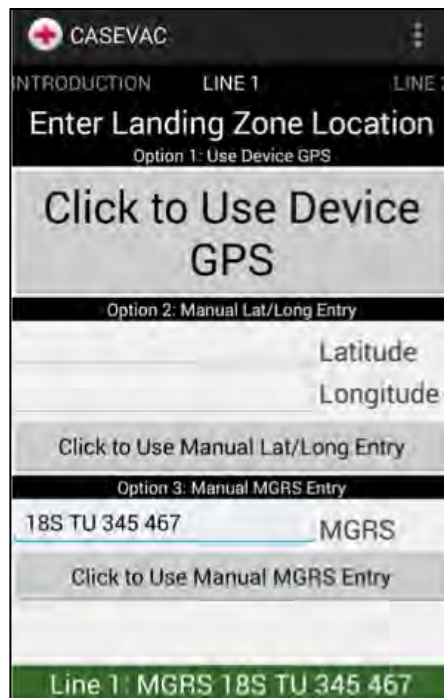


Figure 7. CASEVAC Line 1 After User Input

*c. **Line 2: Frequency/Callsign***

The purpose of line 2 is to provide the responding unit with radio contact information for the unit that has suffered the injury. The response platform will eventually need to speak with the unit. The screen breaks down the line into the following areas:

- (1) **Navigation Bar.** Same description as previous.
- (2) **Line Title.** Same description as previous.
- (3) **Saved Data Field.** This field is populated if the user has previously entered a frequency/net ID and callsign in the settings application.
- (4) **Use Presets Button.** This button is used when the user wants to utilize the saved settings indicated in the previous field. Once pressed, the system creates line 2 with the saved information.
- (5) **Frequency/Net ID EditText.** This field is used to manually input the frequency or net ID. This is used when the user needs to use a different frequency or net ID from the presets.
- (6) **Callsign EditText.** This field is used manually input the desired callsign. This is used when the user needs to use a different callsign from the presets.
- (7) **Use Manual Entry Button.** This button is used when the user wants to use the manually entered frequency/net ID and callsign. The system generates a Toast warning when the either of the required fields is left blank.
- (8) **Line 2 Preview.** Initially this has a red background to indicate to the user that he is not done completing the necessary information. Upon utilizing the presets or manually entering the frequency/net ID, the background color changes to green and line information will populate, indicating that the user is ready to move to the next line.

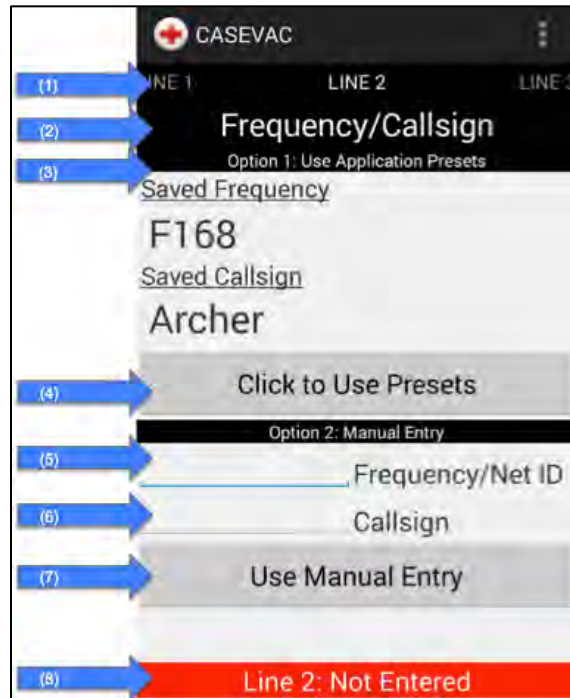


Figure 8. CASEVAC Line 2 Prior to User Input

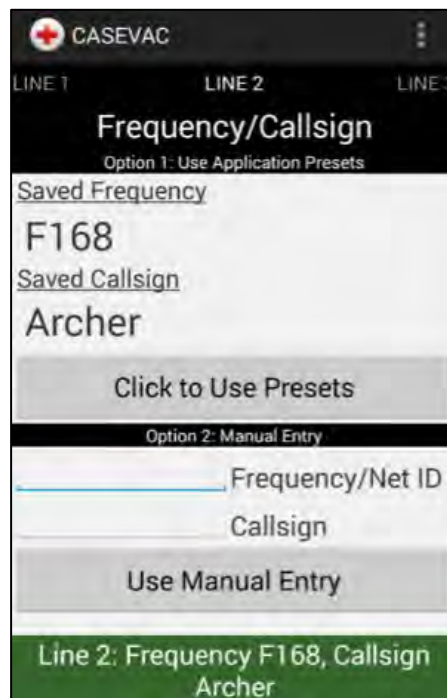


Figure 9. CASEVAC Line 2 After User Input

d. Line 3: Casualties by Precedence

The purpose of line 3 is to assist higher headquarters determine how many response platforms will be dispatched and to where the platforms will deliver the injured Marines. The screen breaks down the line into the following areas:

- (1) **Navigation Bar.** Same description as previous.
- (2) **Line Title.** Same description as previous.
- (3) **Urgent Count Field.** This field indicates the number of patients that the senior medical representative categorizes as urgent. To the left and right of the field are two image buttons⁴, one for incrementing up and another for incrementing down. Pressing either of these increases or decreases the integer count displayed in the field. Touching the text to the right of the button displays a definition of the term.
- (4) **Urgent Surgical Count Field.** This field indicates the number of patients that the senior medical representative categorizes as urgent surgical.
- (5) **Priority Count Field.** This field indicates the number of patients that the senior medical representative categorizes as priority.
- (6) **Routine Count Field.** This field indicates the number of patients that the senior medical representative categorizes as routine.
- (7) **Convenience Count Field.** This field indicates the number of patients that the senior medical representative categorizes as convenience.
- (8) **Line 3 Preview.** Initially this has a red background to indicate to the user that he is not done completing the necessary information. Upon increasing any of the count fields, the background changes to green. Additionally, the total count on this line is used to validate lines 5 and 8 to ensure the user enters matching patient counts. If the user decreases all fields to 0, the background changes back to red and the text resets to “Line 3: Not Entered.”

⁴ Image Button: This is an Android widget that turns an image into a button with functionality.

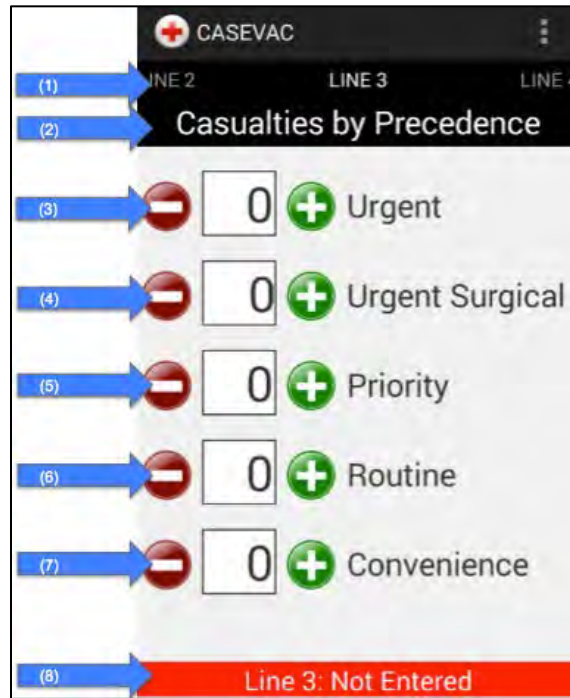


Figure 10. CASEVAC Line 3 Prior to User Input



Figure 11. CASEVAC Line 3 After User Input

e. Line 4: Special Equipment

The purpose of line 4 is to indicate to the flight crew any special equipment that might be needed to assist with the extraction of the injured Marines. The screen breaks down the line into the following areas:

(1) **Navigation Bar.** Same description as previous.

(2) **Line Title.** Same description as previous.

(3) **“None” Checkbox⁵.** When this checkbox is checked, no special equipment is needed for extract. If any of the other boxes on this screen are checked and the user checks this box, the system unchecks all of the other boxes automatically. Additionally, if this box is checked, and another selection is made, the “None” box unchecks.

(4) **“Hoist” Checkbox.** This checkbox should be checked if a hoist is needed to extract the patient(s). A hoist is used in situations where a helicopter is unable to land (usually due to terrain). Touching the text to the right of the button displays a definition of the term.

(5) **“Extraction Equipment” Checkbox.** This checkbox should be checked if particular extraction equipment is needed to extract the patient. This will be followed up with a radio call to the higher headquarters combat operations center with a description as to what is needed. An example of this would be a forest or jungle penetrator in cases of thick foliage.

(6) **“Ventilator” Checkbox.** This checkbox should be checked to indicate that the patient(s) need assistance breathing. The crew will bring a ventilator or additional personnel to assist with cardiopulmonary resuscitation.

(7) **“Other” Checkbox.** This checkbox should be checked to indicate that the patient needs some other type of special equipment that is not listed. The EditText to the right of the title is populated by the user to indicate what equipment is needed.

⁵ Checkbox: This is an Android widget that allows the user to check the box if something is true. A logical call to the field will return “True” if the box is checked, and false otherwise.

(8) **Line 4 Preview.** Initially this has a red background to indicate to the user that he is not done completing the necessary information. Upon checking any of the check boxes, the background turns green and updates the line with the applicable information (letter codes). The background changes back to red and the text resets to “Line 4: Not Entered” if the user unchecks all of the boxes.

The screenshot shows a mobile application interface for CASEVAC. At the top, there is a header with a red cross icon and the text "CASEVAC". Below the header, there are three tabs: "LINE 3", "LINE 4", and "LINE 5". The "LINE 4" tab is selected. The main content area is titled "Special Equipment" and has a subtitle "***Check all that apply***". Below this, there is a list of equipment options, each with a checkbox and a label: "None", "Hoist", "Extraction Equipment", "Ventilator", and "Other". The "Other" option has a text input field next to it with the example text "ex: 2 Backboards". At the bottom of the form, there is a red bar with the text "Line 4: Not Entered". On the left side of the form, there are eight blue arrows pointing to the checkboxes, labeled (1) through (8).

Figure 12. CASEVAC Line 4 Prior to User Input

CASEVAC

LINE 3 LINE 4 LINE 5

Special Equipment

Check all that apply

☐ None

☒ Hoist

☐ Extraction Equipment

☒ Ventilator

☐ Other

Line 4: B, D

Figure 13. CASEVAC Line 4 After User Input

f. Line 5: Number of Patients by Type

The purpose of line 5 is to further assist with the decision of what type and how many response platforms to dispatch. A large number of litter patients could necessitate a platform configured to carry a large amount of litters. The screen breaks down the line into the following areas:

- (1) **Navigation Bar.** Same description as previous.
- (2) **Line Title.** Same description as previous.
- (3) **Reminder.** This field reminds the user of the number of casualties he previously entered in line 3. This helps to ensure that the total number of casualties in line 3 matches that of this line.

- (4) **Litter Count Field.** This field indicates the number of litter patients. Litter patients are defined as those who, due to the severity of wounds, are unable to walk by themselves. To the left and right of the field are two image buttons, one for incrementing up and another for incrementing down. Pressing either of these will

increase or decrease the integer count displayed in the field. Touching the text to the right of the button displays a definition of the term.

(5) **Ambulatory Count Field.** This field indicates the number of ambulatory patients. Ambulatory patients are those who have received minor wounds and are able to walk by themselves.

(6) **Line 5 Preview.** Initially this has a red background to indicate to the user that he is not done completing the necessary information. The text changes upon pressing either of the “up” image buttons to indicate the number of casualties by type. The background changes to green if the total count matches the total casualties indicated in line 3. It turns back to red if the number shifts at all (up or down) to not match the count in line 3. The text resets to “Line 5: Not Entered” if the user zeros out both fields.

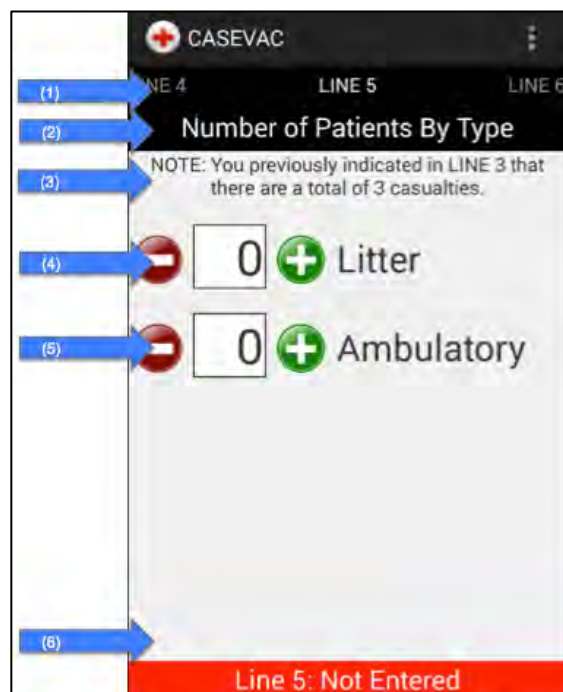


Figure 14. CASEVAC Line 5 Prior to User Input

CASEVAC

LINE 4 LINE 5 LINE 6

Number of Patients By Type

NOTE: You previously indicated in LINE 3 that there are a total of 3 casualties.

Litter

Ambulatory

Line 5: L - 2, A - 1

Figure 15. CASEVAC Line 5 After User Input

g. Line 6: Security at Pickup Site

The purpose of line 6 is to educate the responding pilot about the security in the area around the unit. The screen breaks down the line into the following areas:

- (1) **Navigation Bar.** Same description as previous.
- (2) **Line Title.** Same description as previous.
- (3) **“No Enemy” Radio Button⁶.** The user selects this radio button if there are no indications of enemy activity in the area. Touching the text to the right of the button displays a definition of the term.
- (4) **“Possible Enemy Troops” Radio Button.** The user selects this radio button if there is potential for enemy activity in the area. This selection informs the responding platform to approach with caution.

⁶ Radio Button: This is an Android Widget that allows the user to select a single item from several in a list. Multiple selections are not possible.

(5) **“Enemy Troops in Area” Radio Button.** The user selects this radio button if enemy troops are present, but not within small-arms range of the LZ. This selection informs the responding platform to approach with caution.

(6) **“Armed Escort Required” Radio Button.** The user selects this radio button if enemy troops are present with a quantity/capability to potentially interfere with the CASEVAC platform. This also drives the decision to launch armed aircraft as escorts.

(7) **Line 6 Preview.** Initially this has a red background to indicate to the user that he is not done completing the necessary information. Upon clicking one of the radio buttons, the background color changes to green and the text changes to represent the selection.

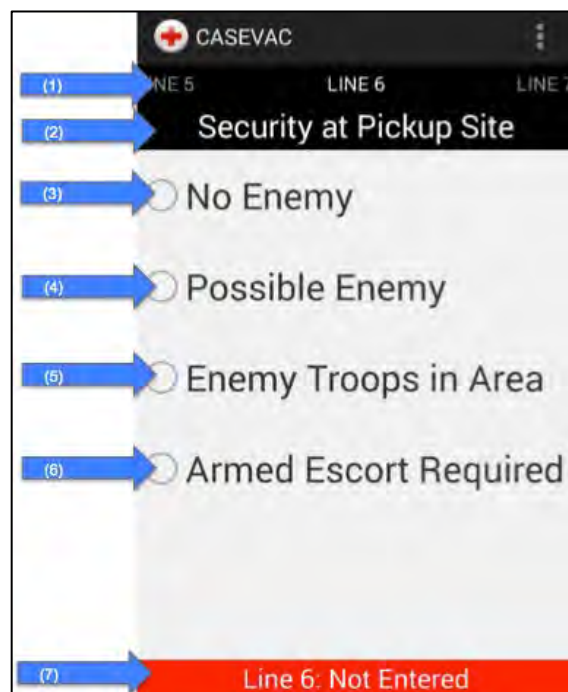


Figure 16. CASEVAC Line 6 Prior to User Input

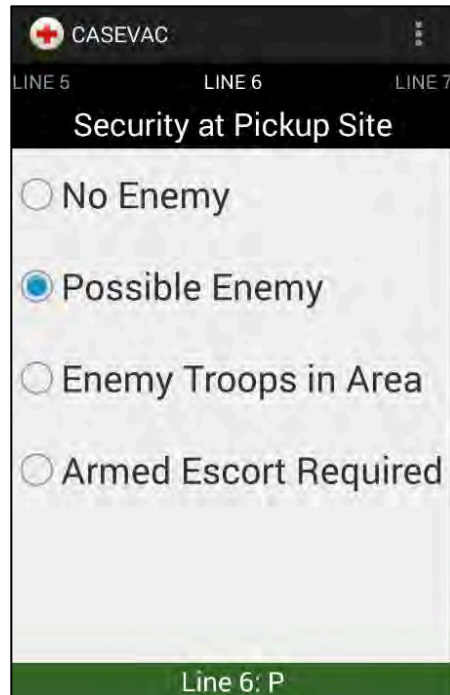


Figure 17. CASEVAC Line 6 After User Input

h. Line 7: Method of Marking Pickup Site

The purpose of line 7 is to inform the pilot of the response platform of the method of marking the landing zone. The screen breaks down the line into the following areas:

- (1) **Navigation Bar.** Same description as previous.
- (2) **Line Title.** Same description as previous.
- (3) **“Panels” Checkbox.** The user will select this checkbox if he desires to mark a landing zone using reflective panels. Touching the text to the right of the button displays a definition of the term.
- (4) **“Pyrotechnic Signals” Checkbox.** The user will select this checkbox if he desires to mark the landing zone with a pyrotechnic signal, such as a flare.
- (5) **“Smoke” Checkbox.** The user will select this checkbox if he desires to mark the landing zone with a smoke grenade or similar technique.
- (6) **“None” Checkbox.** The user will select this checkbox if he will not mark the landing zone or if he has not yet determined the appropriate mark. Selecting “None” will not prevent the CASEVAC platform from launching. He will need to

coordinate with the pilot en route to the landing zone for terminal control. Touching the text to the right of the button displays a definition of the term. If the user selects this box, any other boxes that are checked will be unchecked. If this box is checked and the user selects another box, it will uncheck.

(7) **“Other” Checkbox and EditText Field.** The user will mark this checkbox if he will use a marking technique other than panels, pyrotechnic signal or smoke. For example: an Infrared Chemlight “Buzzsaw”⁷ or NATO Y⁸.

(8) **Line 7 Preview.** Initially this has a red background to indicate to the user that he is not done completing the necessary information. Upon clicking one of the checkboxes, the background color changes to green and the text changes to represent the selection. Any modification to the “Other” EditText field will also change upon typing via keystroke listener.

⁷ IR Buzzsaw: Technique of marking a landing zone in low light situations achieved by attaching an infrared chemlight to a length of cord and spinning it at high speeds. This is visible to pilots using night vision goggles.

⁸ NATO Y: Technique of marking a landing zone using chemlights strung together in the shape of the letter “Y”. The direction of the Y indicates in which direction the troops on the ground desire the aircraft to land.

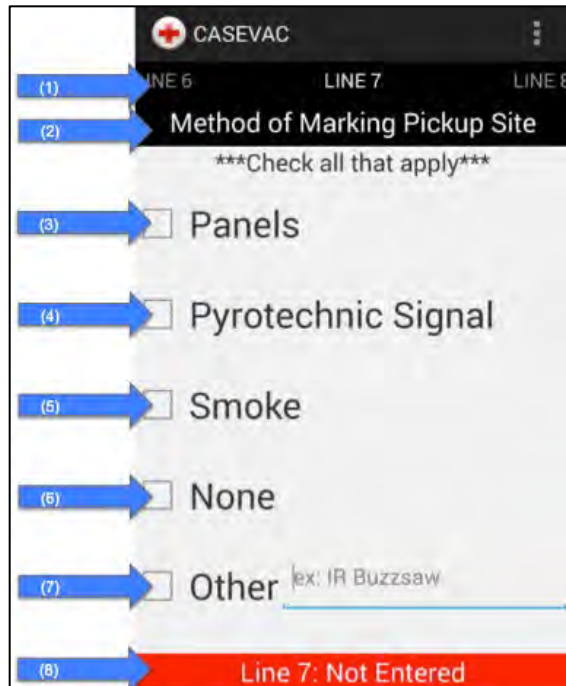


Figure 18. CASEVAC Line 7 Prior to User Input

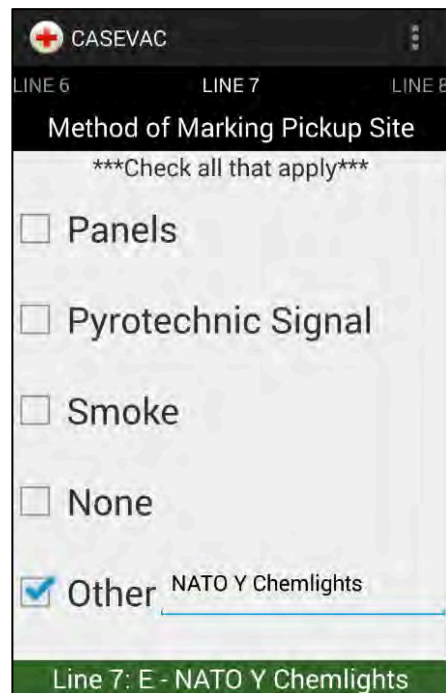


Figure 19. CASEVAC Line 7 After User Input

i. Line 8: Patient Nationality and Status

The purpose of line 8 is to inform higher headquarters and the response platform about the nationality and status of the patients. United State Military patients may or may not go to the same hospital as civilians, and foreign nationals might fall under different medical rules of engagement. Prisoners of war might require an armed guard. The screen breaks down the line into the following areas:

- (1) **Navigation Bar.** Same description as previous.
- (2) **Line Title.** Same description as previous.
- (3) **Reminder.** Same description as previous (Line 5).
- (4) **“U.S. Military” Count Field.** This field indicates the number of patients that are U.S. Military. To the left and right of the field are two image buttons, one for incrementing up and the other for decrementing. Pressing either of these will increase or decrease the integer count displayed in the field. Touching the text to the right of the button displays a definition of the term.
- (5) **“U.S. Civilian” Count Field.** This field indicates the number of patients that are U.S. Civilians..
- (6) **“Non-U.S. Military” Count Field.** This field indicates the number of patients that are Non-U.S. Military (such as partnered/allied nation forces).
- (7) **Non-U.S. Civilian Count Field.** This field indicates the number of patients that are Non-U.S. Civilians (such as interpreters or aid workers).
- (8) **“EPW” Count Field.** This field indicates the number of patients that are Enemy Prisoners of War.
- (9) **Line 8 Preview.** Initially this has a red background to indicate to the user that he is not done completing the necessary information. The text changes upon pressing either of the “up” image buttons to indicate the number of casualties by type. The background changes to green if the total count matches the total casualties indicated in line 3. It will turn back to red if the number shifts at all (up or down) to not match the count in line 3. The text will reset to “Line 5: Not Entered” if the user zeros out both fields.

CASEVAC

LINE 7 LINE 8 LINE 9

Patient Nationality and Status

NOTE: You previously indicated in LINE 3 that there are a total of 3 casualties.

(4) U.S. Military

(5) U.S. Civilian

(6) Non-U.S. Military

(7) Non-U.S. Civilian

(8) EPW

(9) **Line 8: Not Entered**

Figure 20. CASEVAC Line 8 Prior to User Input

CASEVAC

LINE 7 LINE 8 LINE 9

Patient Nationality and Status

NOTE: You previously indicated in LINE 3 that there are a total of 3 casualties.

U.S. Military

U.S. Civilian

Non-U.S. Military

Non-U.S. Civilian

EPW

Line 8: A - 2, D - 1

Figure 21. CASEVAC Line 8 After User Input

j. Line 9: Nuclear, Biological, Chemical Contamination

The purpose of line 9 is to warn the response platform about the presence of any contamination in the area. The screen breaks down the line into the following areas:

- (1) **Navigation Bar.** Same description as previous.
- (2) **Line Title.** Same description as previous.
- (3) **Line Description.** Same description as previous.
- (4) **“None” Checkbox.** The user will select this checkbox if there is no contamination in the area. If other checkboxes are checked and the user selects “None,” the other boxes will uncheck. Additionally, if this box is checked and the user selects a level of contamination, the “None” box will uncheck.
- (5) **“Nuclear” Checkbox.** The user will select this if there is nuclear contamination in the area (fallout from nuclear weapons, disasters involving nuclear power plants, etc).
- (6) **“Biological” Checkbox.** The user will select this if there is biological contamination in the area.
- (7) **“Chemical” Checkbox.** The user will select this if there is chemical contamination in the area.
- (8) **Line 9 Preview.** Initially this has a red background to indicate to the user that he is not done completing the necessary information. Upon checking any of the check boxes, the background will turn green and update the line with the applicable information (letter codes). The background changes back to red and the text will reset to “Line 4: Not Entered” if the user unchecks all of the boxes.

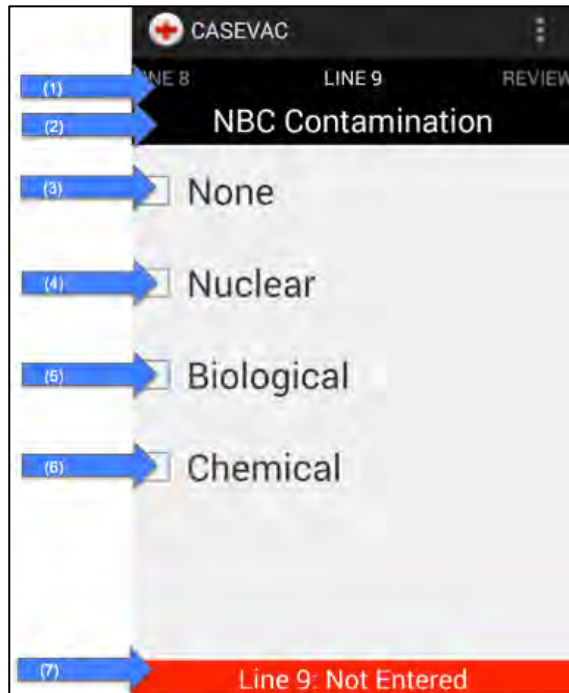


Figure 22. CASEVAC Line 9 Prior to User Input

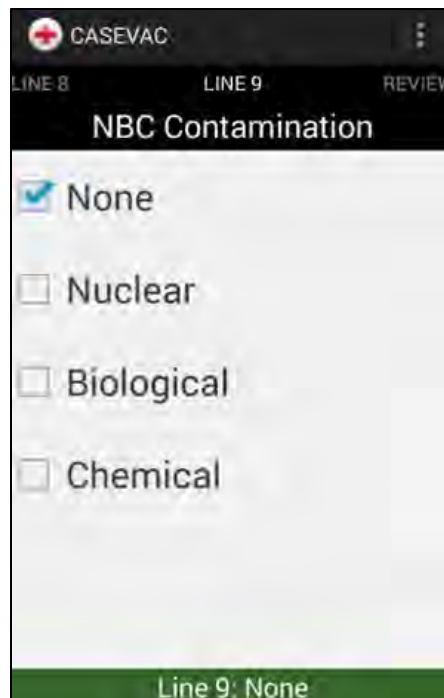


Figure 23. CASEVAC Line 9 After User Input

k. Final 9-Line

The purpose of the final line is to provide the user with a chance to review his or her inputs and send the request by his or her preferred method (digital or voice). The screen breaks down the line into the following areas:

- (1) **Navigation Bar.** Same description as previous.
- (2) **Line Title.** Same description as previous.
- (3) **Line Description.** Instructs the user to review the information in the 9-Line and press the “Digital” button to transmit digitally or “Voice” button to display the voice transmission format.

(4) **Line Data.** This is the plaintext version of the user’s input that was used to populate the lines. This is in plain English vice line data format for ease of review by the user. The data is properly formatted prior to digital transmission or display to the user for voice transmission.

(5) **“Digital” Image Button.** This puts some connectivity information and line data into an array for transmission to the sender’s higher headquarters. The information is sent as a string array containing the following:

- Index 0: The string “CASEVAC.” The distant end uses this string for identifying what type of message is being received.
- Index 1: String containing the plaintext unit title to inform the supporting headquarters from whom the CASEVAC request is originating.
- Index 2: String containing the Internet protocol (IP) address of the sending device. This is used for the distant end to acknowledge receipt.
- Index 3: String containing line 1.
- Index 4: String containing line 2.
- Index 5: String containing line 3.
- Index 6: String containing line 4.
- Index 7: String containing line 5.
- Index 8: String containing line 6.
- Index 9: String containing line 7.
- Index 10: String containing line 8.
- Index 11: String containing line 9

(6) **“Voice” Image Button.** This button displays the 9-Line in proper format for digital transmission. This is used when there is no digital connectivity.

(7) **Final 9-Line Indicator.** Initially this has a red background to indicate to the user that he has not transmitted the 9-Line to his higher headquarters. Upon pressing the “Digital” button, the application transmits the data array to the IP address and port as indicated in the preset settings. Upon receipt by the user’s higher headquarters, an acknowledgement message is sent back and the background color changes to green and the text changes to “Acknowledged By Server.”

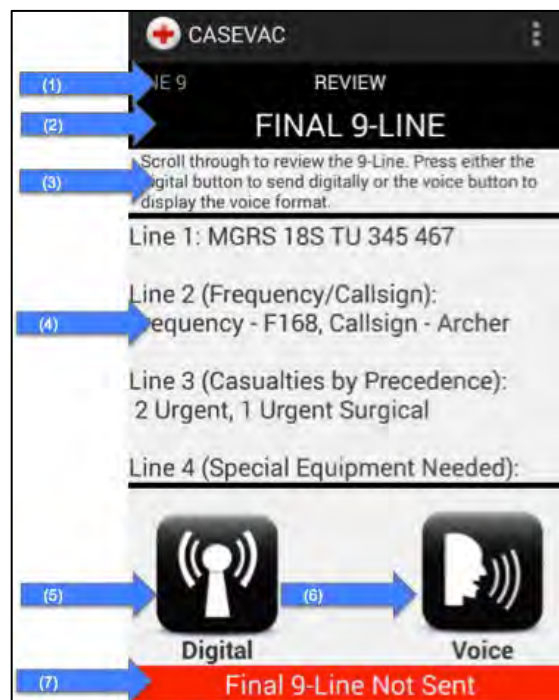


Figure 24. CASEVAC Final 9-Line

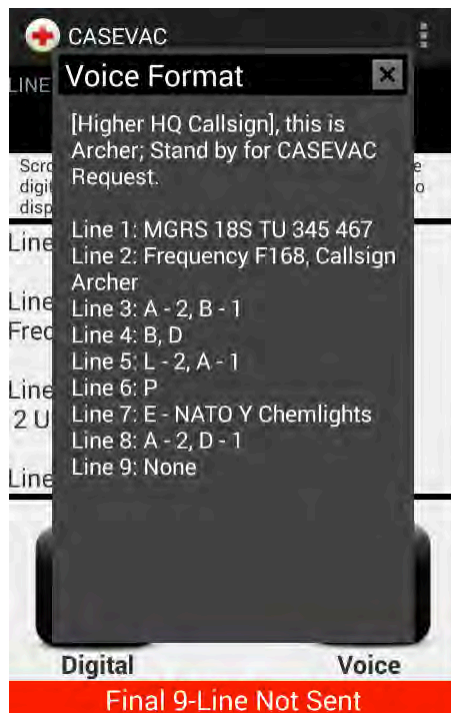


Figure 25. CASEVAC Voice Format Display



Figure 26. CASEVAC Final 9-Line After Digital Transmission

3. EOD/UXO Application

The EOD/UXO application is intended to help generate an EOD/UXO request. In this section, each screen in the application is explained in depth.

a. Welcome Screen

This screen is to inform the user about basic functionality of the application. The screen describes how to reach the settings application, how to navigate to the different lines, and how to display the definitions of unfamiliar terms.

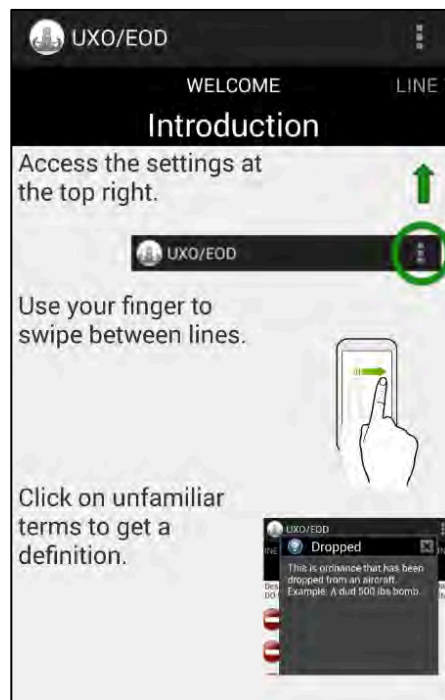


Figure 27. UXO/EOD Welcome Screen

b. Line 1: Date Time Group

The purpose of the line is to indicate to the responding EOD team what time the device or ordnance in question was found. The user has several options to populate the time the item was found. The screen breaks down the line into the following areas:

- (1) **Navigation Bar.** This assists the user by indicating what line he is currently on.

(2) **Line Title.** Indicates the title of the line.

(3) **“Use Current Time” Button.** This button generates the current date time group (DTG) to indicate the time that the ordnance was found. A military DTG is formatted as DDTTTTZZMMYY. DD indicates the two digit date of the month, TTTT indicates the 24 hour time, Z indicates the current time zone (if other than Zulu/Greenwich Mean Time), MMM indicates the three letter abbreviation for the month, and YY indicates the two digit year.

(4) **Manual Time Entry EditText.** This field is for the user to manually enter in a time the ordnance was found. This would be used if another entity (adjacent unit without communication capability, local national civilian, etc) discovered the ordnance at a previous time.

(5) **“Manual Entry” Button.** This button generates the DTG based upon the user’s input into the above EditText field. If the EditText field is blank, an error Toast is generated and displayed to the user.

(6) **Line 1 Preview.** Initially this has a red background to indicate to the user that he is not done completing the necessary information. Upon either selecting the current DTG button or manual entry button, the background will turn green and update the line with the applicable information (DTG ordnance was found). The background changes back to red and the text will reset to “Line 1: Not Entered” if the user tries to change his entry to a manual entry with nothing populated for the EditText field.

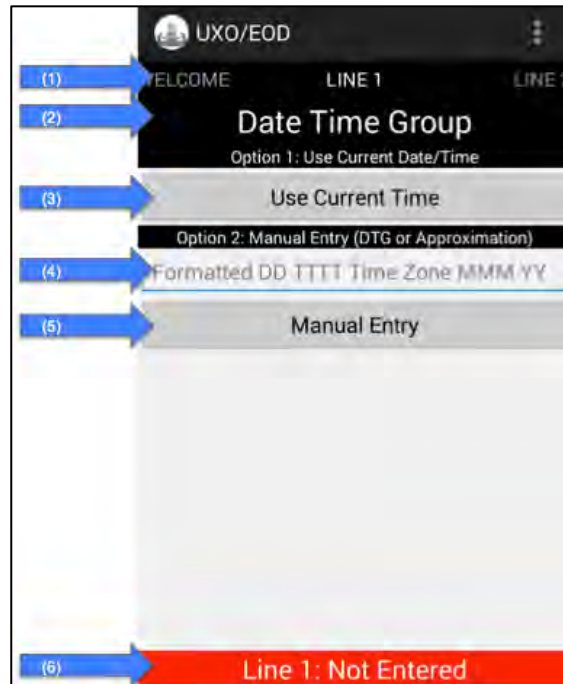


Figure 28. UXO/EOD Line 1 Prior to User Input

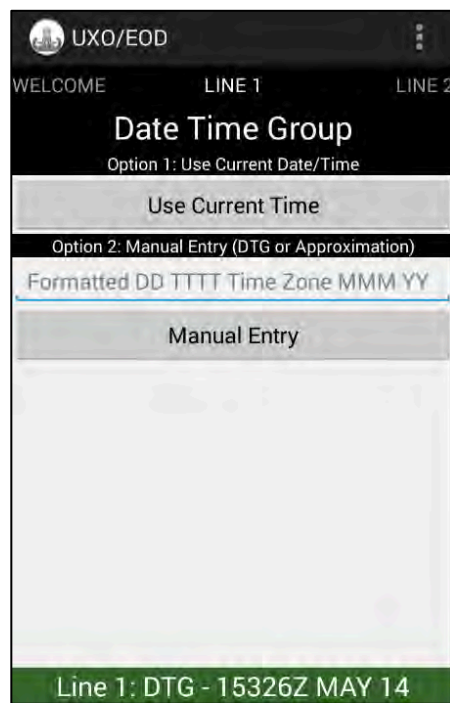


Figure 29. UXO/EOD Line 1 After User Input

c. Line 2: Reporting Activity

The purpose of line 2 is to indicate the unit that found the device or ordnance. The screen breaks down the line into the following areas:

- (1) **Navigation Bar.** Same as previous description.
- (2) **Line Title.** Same as previous description.
- (3) **Current Unit ID.** This field is populated by the HELP Settings database that is set by the user.
- (4) **“Use GPS” Button.** This button causes the line data to be created using the device’s GPS in latitude/longitude.
- (5) **“Manual MGRS” EditText.** This field is for the user to manually enter the location of the ordnance using MGRS.
- (6) **“Use Manual MGRS Input” Button.** This button is used after the user inputs a manual MGRS grid in the above field. If the entry is blank, an error Toast is generated. If there is an entry in the above field, the line information is generated.
- (7) **Line 2 Preview.** Initially this has a red background to indicate to the user that he is not done completing the necessary information. Upon either selecting the “Use GPS” button or manual entry button, the background will turn green and update the line with the applicable information (Unit ID and Location). The background changes back to red and the text will reset to “Line 2: Not Entered” if the user tries to change his entry to a manual entry with nothing populated for the EditText field.

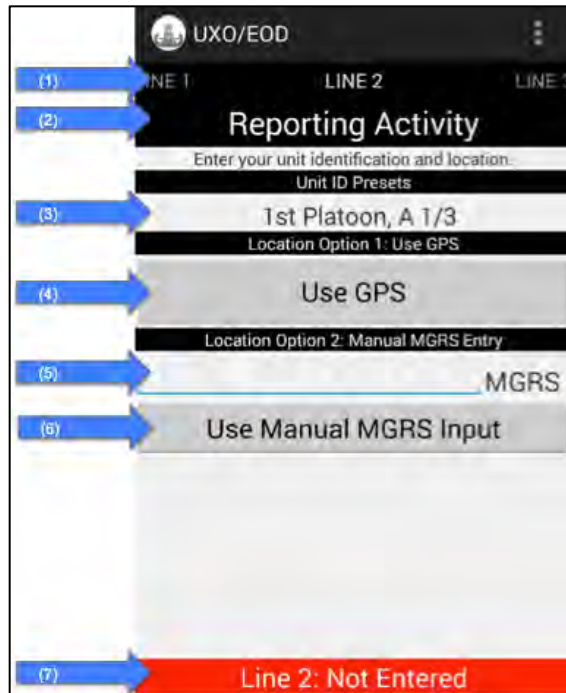


Figure 30. UXO/EOD Line 2 Prior to User Input

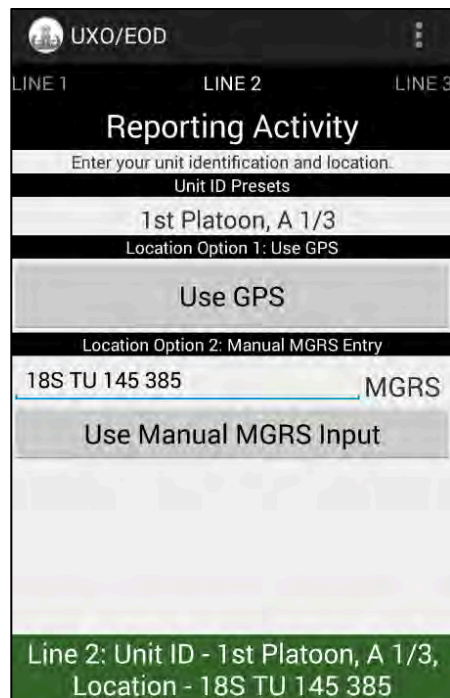


Figure 31. UXO/EOD Line 2 After User Input

d. Line 3: Contact Method

During any EOD response, the responding team must conduct coordination with the unit that found the device. Line 3 establishes the unit name and point of contact information. The screen breaks down the line into the following areas:

- (1) **Navigation Bar.** Same as previous description.
- (2) **Line Title.** Same as previous description.
- (3) **“POC Name” EditText.** This field is used to populate the primary point of contact with whom coordination will occur by supporting explosive ordnance disposal personnel.
- (4) **Saved Frequency/NetID.** This field is populated by the HELP Settings database that is set by the user. This indicates the current frequency that the requesting unit is monitoring.
- (5) **Saved Callsign.** This field is populated by the HELP Settings database that is set by the user. This indicates the current callsign of the requesting unit.
- (6) **“Use Presets” Button.** This button creates the line data with the presets that are currently displayed. If the button is pressed without an entry in the POC Name field, an error Toast will remind the user to populate a primary POC.
- (7) **Manual Frequency/NetID EditText.** This field is populated by the user if he wants to use a different Frequency/NetID than what is currently saved in the settings database.
- (8) **Manual Callsign EditText.** This field is populated by the user if he wants to use a different callsign than what is currently saved in the settings database.
- (9) **“Use Manual Entry” Button.** This button is pressed after the user enters the previous two fields. If one or both of the fields are left blank, an error Toast is displayed to remind the user to complete the entries.
- (10) **Line 3 Preview.** Initially this has a red background to indicate to the user that he is not done completing the necessary information. Upon either selecting the “Use Presets” button or “Use Manual Entry” button, the background will turn green and update the line with the applicable information (POC, Frequency/NetID, Callsign). The background changes back to red and the text will reset to “Line 3: Not Entered” if

the user tries to change/alter his entry to a manual entry with nothing populated for the proper EditText fields.

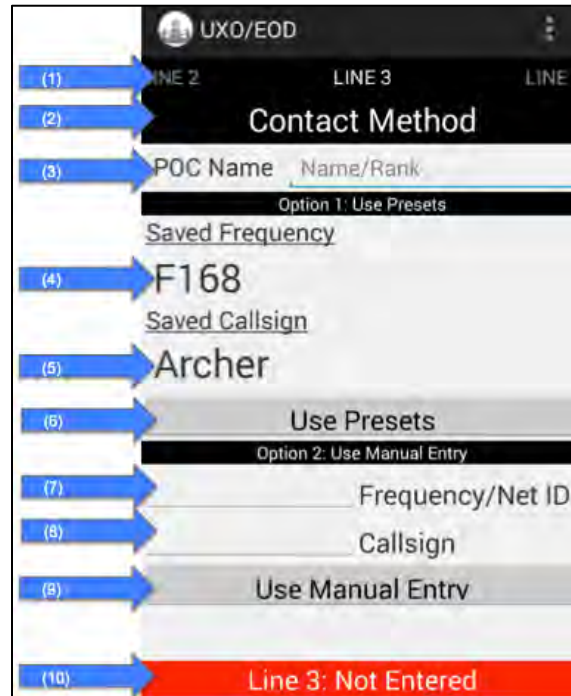


Figure 32. UXO/EOD Line 3 Prior to User Input

Figure 33. UXO/EOD After User Input

e. Line 4: Type of Ordnance

The purpose of line 4 is to provide the responding EOD team with basic information about the quantity of devices. Once this information is known, the EOD unit can further task organize for a proper response. The screen breaks down the line into the following areas:

(1) **Navigation Bar.** Same as previous description.

(2) **Line Title.** Same as previous description.

(3) **Dropped Count Field.** This field indicates the number of dropped ordnance devices. Dropped ordnance are those which have been dropped by an aviation platform but failed to detonate/function. To the left and right of the field are two image buttons, one for incrementing up and the other for decrementing. Pressing either of these will increase or decrease the integer count displayed in the field. Touching the text to the right of the button displays a definition of the term.

(4) **Projected Count Field.** This field indicates the number of projected ordnance devices. Dropped ordnance are those which have been fired from an indirect fire weapon system, such as an artillery piece, but failed to detonate/function.

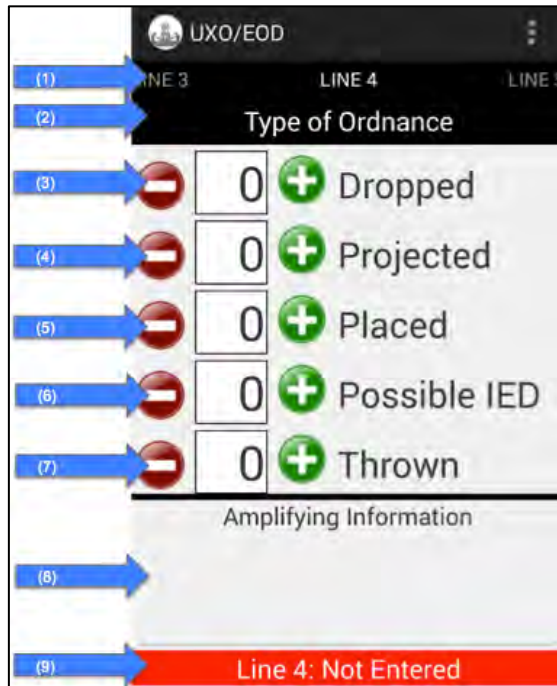
(5) **Placed Count Field.** This field indicates the number of placed ordnance devices. Dropped ordnance are those which have been out into position by a person. An example of placed ordnance might be a weapons cache or munitions dump.

(6) **Possible Improvised Explosive Device (IED) Count.** Dropped Count Field. This field indicates the number of possible IEDs. Improvised Explosive Devices are devices that are homemade and function in ways other than conventional means.

(7) **Thrown Count Field.** This field indicates the number of thrown devices. Thrown devices are things such as hand grenades that failed to function/detonate.

(8) **Amplifying Information EditText.** This field is populated to give any sort of amplifying information to EOD personnel that might help prepare them for the disposal mission. A user might indicate a brief description of the device(s), and indications of tampering, command wires, or any other pertinent information.

(9) **Line 4 Preview.** Initially this has a red background to indicate to the user that he is not done completing the necessary information. Upon increasing any of the device count fields, the background changes to green to indicate to the user that the required information has been populated. The background changes back to red and the text will reset to “Line 4: Not Entered” if the user decreases all of the device counts to 0.



UXO/EOD

LINE 3 LINE 4 LINE 5

Type of Ordnance

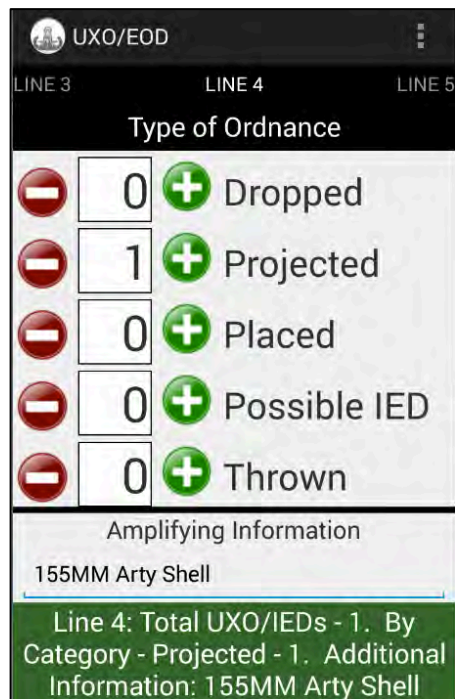
(3)	<input type="radio"/>	0	<input type="checkbox"/>	Dropped
(4)	<input type="radio"/>	0	<input type="checkbox"/>	Projected
(5)	<input type="radio"/>	0	<input type="checkbox"/>	Placed
(6)	<input type="radio"/>	0	<input type="checkbox"/>	Possible IED
(7)	<input type="radio"/>	0	<input type="checkbox"/>	Thrown

Amplifying Information

(8)

(9) Line 4: Not Entered

Figure 34. UXO/EOD Line 4 Prior to User Input



UXO/EOD

LINE 3 LINE 4 LINE 5

Type of Ordnance

<input type="radio"/>	0	<input type="checkbox"/>	Dropped
<input type="radio"/>	1	<input type="checkbox"/>	Projected
<input type="radio"/>	0	<input type="checkbox"/>	Placed
<input type="radio"/>	0	<input type="checkbox"/>	Possible IED
<input type="radio"/>	0	<input type="checkbox"/>	Thrown

Amplifying Information

155MM Arty Shell

Line 4: Total UXO/IEDs - 1. By Category - Projected - 1. Additional Information: 155MM Arty Shell

Figure 35. UXO/EOD Line 4 After User Input

f. Line 5: CBRNE Contamination

The presence of CBRNE contamination during any operation is critical information. Line 5 provides the EOD team with any information about potential contamination. The screen breaks down the line into the following areas:

- (1) **Navigation Bar.** Same as previous description.
- (2) **Line Title.** Same as previous description.
- (3) **“None” Checkbox.** This is checked by the user when there is no indication of Chemical, Biological, Radiological, or Nuclear contamination.
- (4) **“Nuclear” Checkbox.** This checkbox is checked by the user if there is any presence of nuclear contamination.
- (5) **“Biological” Checkbox.** This checkbox is checked by the user if there is any presence of biological contamination.
- (6) **“Chemical” Checkbox.** This checkbox is checked by the user if there is any presence of chemical contamination.
- (7) **“Amplifying Information” EditText.** This field is for the user to provide any additional information about the contamination present.
- (8) **Line 5 Preview.** Initially this has a red background to indicate to the user that he is not done completing the necessary information. Upon increasing checking any of the boxes, the background changes to green to indicate to the user that the required information has been populated. The background changes back to red and the text will reset to “Line 5: Not Entered” if the user deselects all of the checkboxes.

UXO/EOD

LINE 4 LINE 5 LINE 6

CBRNE Contamination

Indicate any potential chemical, biological, or nuclear contamination potential.

(3) ☐ None

(4) ☐ Nuclear

(5) ☐ Biological

(6) ☐ Chemical

Amplifying Information

(7)

(8) Line 5: Not Entered

Figure 36. UXO/EOD Line 5 Prior to User Input

UXO/EOD

LINE 4 LINE 5 LINE 6

CBRNE Contamination

Indicate any potential chemical, biological, or nuclear contamination potential.

☒ None

☐ Nuclear

☐ Biological

☐ Chemical

Amplifying Information

Line 5: None

Figure 37. UXO/EOD Line 5 Prior to User Input

g. Line 6: Resources Threatened

The purpose of line 6 is to give higher headquarters an indication of any critical resources or infrastructure that might be threatened by an IED or ordnance. This information can help prioritize the response. The screen breaks down the line into the following areas:

- (1) **Navigation Bar.** Same as previous description.
- (2) **Line Title.** Same as previous description.
- (3) **“Resources Threatened” EditText.** This field is populated by the user to indicate what, if any, resources, facilities, or assets are threatened by the device being reported.
- (4) **Line 6 Preview.** Initially this has a red background to indicate to the user that he is not done completing the necessary information. Upon populating the above field, the color changes from red to green. The background changes back to red and the text will reset to “Line 6: Not Entered” if the user deletes the entry to the above field.

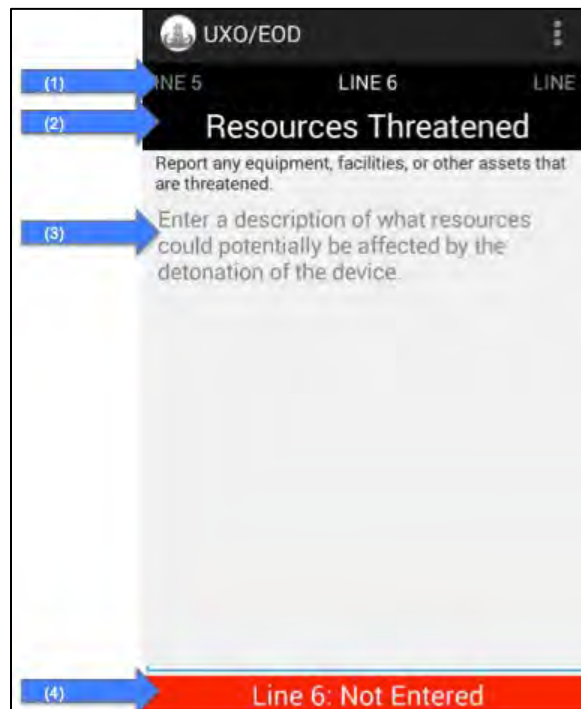


Figure 38. UXO/EOD Line 6 Prior to User Input

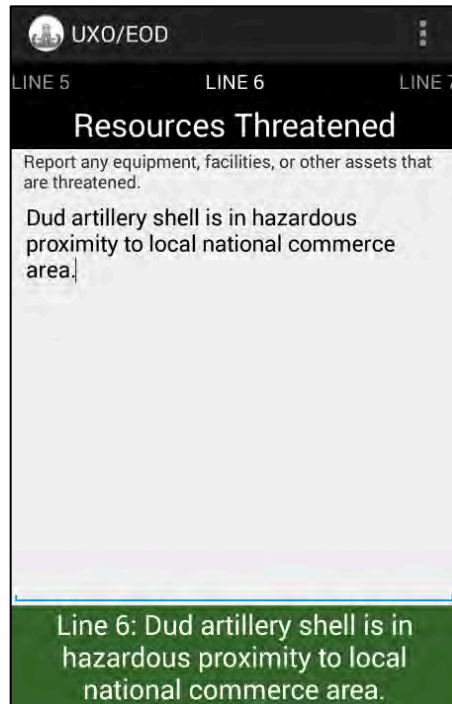


Figure 39. UXO/EOD Line 6 After User Input

h. Line 7: Impact on Mission

The purpose of line 7 is to provide higher headquarters with a snapshot of how the ordnance or IED is affecting the current mission. This also helps prioritize the response. The screen breaks down the line into the following areas:

- (1) **Navigation Bar.** Same as previous description.
- (2) **Line Title.** Same as previous description.
- (3) **“Impact on Mission” EditText.** This field is populated by the user to indicate what impact, if any, the device is having on the unit’s current mission.
- (4) **Line 7 Preview.** Initially this has a red background to indicate to the user that he is not done completing the necessary information. Upon populating the above field, the color changes from red to green. The background changes back to red and the text will reset to “Line 7: Not Entered” if the user deletes the entry to the above field.



Figure 40. UXO/EOD Line 7 Prior to User Input

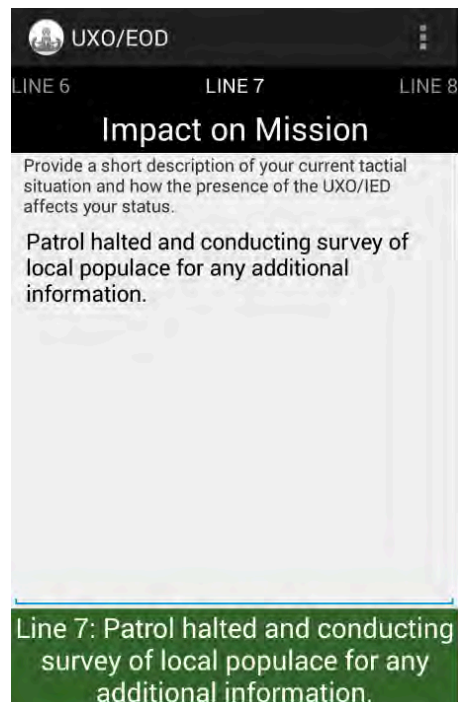


Figure 41. UXO/EOD Line 7 After User Input

i. Line 8: Protective Measures

The purpose of line 8 is to further develop the situational awareness of higher headquarters about what the discovering unit is doing to protect personnel and equipment. This also helps prioritize a response. The screen breaks down the line into the following areas:

- (1) **Navigation Bar.** Same as previous description.
- (2) **Line Title.** Same as previous description.
- (3) **“Protective Measures” EditText.** This field is populated by the user to indicate what protective measures, if any, the unit has taken to mitigate risk from the device(s).
- (4) **Line 8 Preview.** Initially this has a red background to indicate to the user that he is not done completing the necessary information. Upon populating the above field, the color changes from red to green. The background changes back to red and the text will reset to “Line 8: Not Entered” if the user deletes the entry to the above field.



Figure 42. UXO/EOD Line 8 Prior to User Input

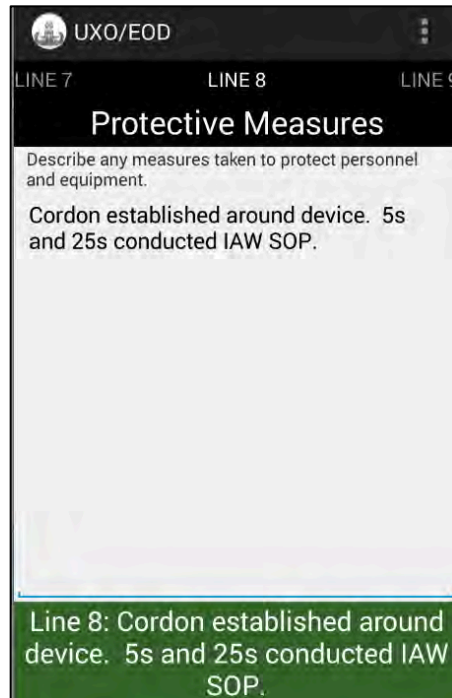


Figure 43. UXO/EOD Line 8 After User Input

j. Line 9: Recommended Priority

The purpose of line 9 is to assist higher headquarters prioritize a response. The screen breaks down the line into the following areas:

- (1) **Navigation Bar.** Same as previous description.
- (2) **Line Title.** Same as previous description.
- (3) **“Immediate” Radio Button.** The user selects this when the presence of the ordnance has stopped the unit’s maneuver and mission capability or threatens critical assets vital to their mission. Clicking on the text displays a definition of “Immediate.”
- (4) **“Indirect” Radio Button.** The user selects this when the presence of the ordnance has slowed the unit’s maneuver and mission capability or threatens critical assets important to the mission. Clicking on the text displays a definition of “Indirect.”

(5) **“Minor” Radio Button.** This is selected by the user when the presence of the ordnance reduces the unit’s maneuver and mission capability or threatens non-critical assets of little value. Clicking on the text displays a definition of “Minor.”

(6) **“No Threat” Radio Button.** This is selected by the user when the presence of the ordnance presents little or no threat to the unit’s mission. Clicking on the text displays a definition of “No Threat.”

(7) **Line 9 Preview.** Initially this has a red background to indicate to the user that he is not done completing the necessary information. Upon populating the above field, the color changes from red to green. The background changes back to red and the text will reset to “Line 9: Not Entered” if the user deletes the entry to the above field.



Figure 44. UXO/EOD Line 9 Prior to User Input

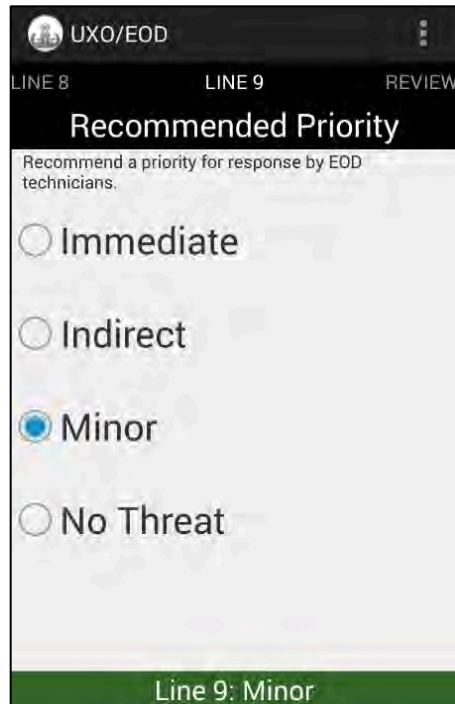


Figure 45. UXO/EOD Line 9 After User Input

k. Final 9-Line

The purpose of the final line is to provide the user with a chance to review his or her inputs and send the request by his or her preferred method (digital or voice). The screen breaks down the line into the following areas:

- (1) **Navigation Bar.** Same description as previous.
- (2) **Line Title.** Same description as previous.
- (3) **Line Description.** Instructs the user to review the information in the 9-Line and press the “Digital” button to transmit digitally or “Voice” button to display the voice transmission format.
- (4) **Line Data.** This is the plaintext version of the user’s input that was used to populate the lines. This is in plain English vice line data format for ease of review by the user. The data is properly formatted prior to digital transmission or display to the user for voice transmission.

(5) **“Digital” Image Button.** This puts some connectivity information and line data into an array for transmission to the sender’s higher headquarters. The information is sent as a string array containing the following:

- Index 0: The string “UXOEOD.” The distant end uses this string for identifying what type of message is being received.
- Index 1: String containing the plaintext unit title to inform the supporting headquarters from whom the UXO/EOD request is originating.
- Index 2: String containing the Internet protocol (IP) address of the sending device. This is used for the distant end to acknowledge receipt.
- Index 3: String containing line 1.
- Index 4: String containing line 2.
- Index 5: String containing line 3.
- Index 6: String containing line 4.
- Index 7: String containing line 5.
- Index 8: String containing line 6.
- Index 9: String containing line 7.
- Index 10: String containing line 8.
- Index 11: String containing line 9

(6) **“Voice” Image Button.** This button displays the 9-Line in proper format for digital transmission. This is used when there is no digital connectivity.

(7) **Final 9-Line Indicator.** Initially this has a red background to indicate to the user that he has not transmitted the 9-Line to his higher headquarters. Upon pressing the “Digital” button, the application transmits the data array to the IP address and port as indicated in the preset settings. Upon receipt by the user’s higher headquarters, an acknowledgement message is sent back and the background color changes to green and the text changes to “Acknowledged By Server.”

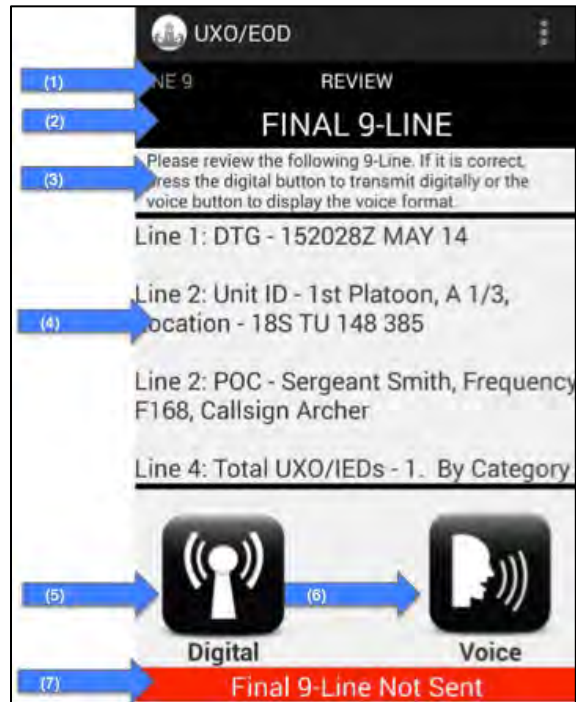


Figure 46. UXO/EOD Final 9-Line Review

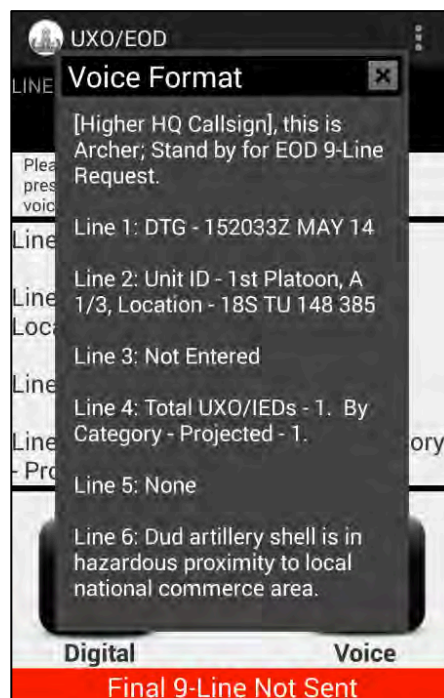


Figure 47. UXO/EOD Voice Format Display

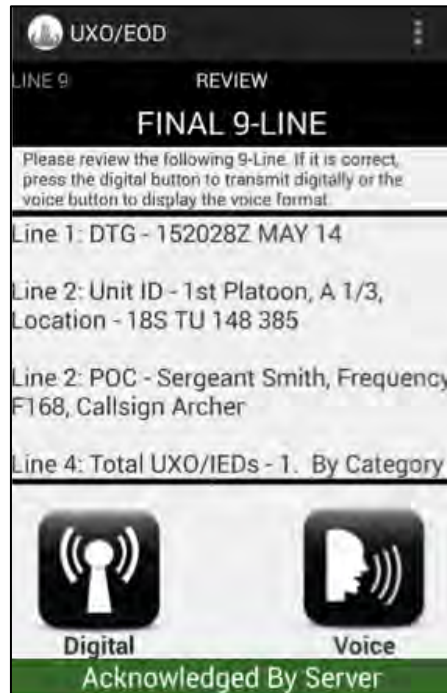


Figure 48. UXO/EOD Final 9-Line After Digital Transmission

4. Rapid Request Application

The Rapid Request application is intended to help generate a Rapid Logistics request. In this section, each screen in the application is explained in depth.

a. Welcome Screen

This screen is to inform the user about basic functionality of the application. The screen describes how to reach the settings application, how to navigate to the different lines, and how to display the definitions of unfamiliar terms.



Figure 49. Rapid Request Welcome Screen

b. Line 1: Unit Name/POC

The purpose of line 1 is to identify the requesting unit to higher headquarters. The screen breaks down the line into the following areas:

- (1) **Navigation Bar.** This assists the user by indicating what line he is currently on.
- (2) **Line Title.** Indicates the title of the line.
- (3) **Point of Contact (POC) Name EditText.** This field is used to indicate the primary point of contact with whom any coordination will occur.
- (4) **Saved Unit.** This is the saved Unit ID that is currently saved in the HELP Settings database.
- (5) **Saved Frequency/NetID.** This is the saved Frequency/NetID that is currently saved in the HELP Settings database.
- (6) **“Click to Use Presets” Button.** This button is pressed if the user desires to use the preset unit ID and frequency/NetID. If the primary POC field is left blank, an error Toast is displayed to the user.

(7) **“Manual Unit Entry” EditText.** This field is populated by the user if he does not want to use the unit ID currently saved in the settings database.

(8) **Manual Frequency/NetID EditText.** This field is populated by the user if he does not want to use the frequency/NetID saved in the settings database.

(9) **“Manual Entry” Button.** This is pressed by the user upon completion of the previous two fields. If either of the previous fields were left blank, an error Toast is displayed to the user.

(10) **Line 1 Preview.** Initially this has a red background to indicate to the user that he is not done completing the necessary information. Upon populating the proper fields and pressing either the Use Presets or Manual Entry buttons, the color changes from red to green. The background changes back to red and the text will reset to “Line 1: Not Entered” if the user deletes required information and attempts to press either of the buttons.

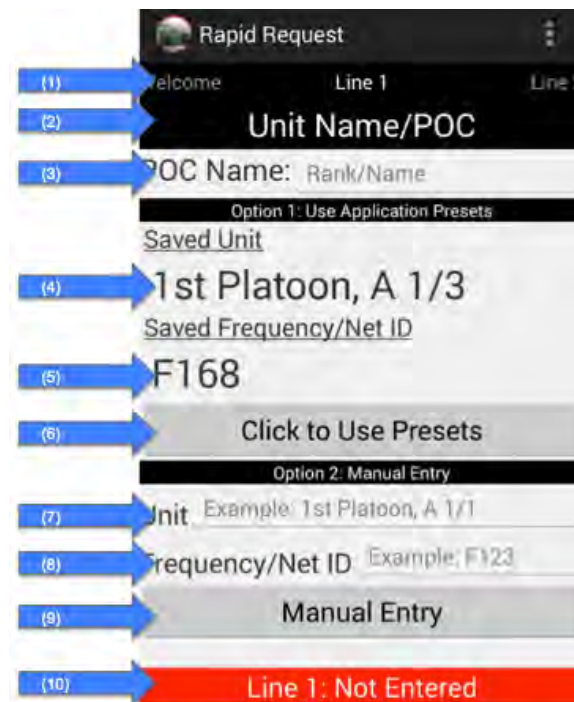


Figure 50. Rapid Request Line 1 Prior to User Input

Rapid Request

Welcome Line 1 Line 2

Unit Name/POC

POC Name: Sergeant Smith

Option 1: Use Application Presets

Saved Unit

1st Platoon, A 1/3

Saved Frequency/Net ID

F168

Click to Use Presets

Option 2: Manual Entry

Unit Example: 1st Platoon, A 1/1

Frequency/Net ID Example: F123

Line 1: 1st Platoon, A 1/3,
Frequency/NetId - F168, POC -
Sergeant Smith

Figure 51. Rapid Request Line 1 After User Input

c. Line 2: Precedence

The purpose of line 2 is to identify how important the requested support is to the unit's mission. This helps higher headquarters prioritize a response. The screen breaks down the line into the following areas:

- (1) **Navigation Bar.** Same as previous description.
- (2) **Line Title.** Same as previous description.
- (3) **“Routine” Radio Button.** This button is selected by the user to indicate that the request is routine in nature and not an emergency. The user should expect prosecution of the request within 72 hours.
- (4) **“Priority” Radio Button.** This button is selected by the user to indicate that the request should be a priority of the supporting headquarters and support is mission critical. The user should expect prosecution of the request within 24 hours.
- (5) **“Emergency” Radio Button.** This button is selected by the user to indicate that support is needed as soon as possible and that lack of immediate response will result in mission failure.

(6) **Line 2 Preview.** Initially this has a red background to indicate to the user that he is not done completing the necessary information. Upon pressing any of the radio buttons, the color changes from red to green.



Figure 52. Rapid Request Line 2 Prior to User Input

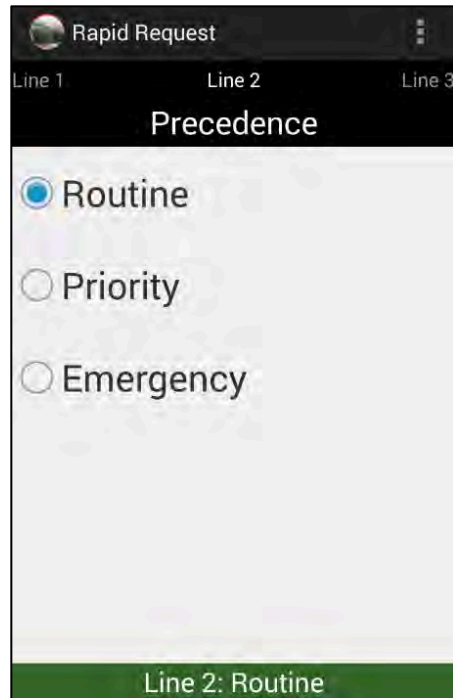


Figure 53. Rapid Request Line 2 After User Input

d. Line 3: Type of Request

The purpose of line 3 is to indicate what type of request follows. The input to this screen potentially generates additional lines for the user to populate, as described below. The screen breaks down the line into the following areas:

- (1) **Navigation Bar.** Same as previous description.
- (2) **Line Title.** Same as previous description.
- (3) **“Resupply” CheckBox.** This box is checked by the user to indicate the he needs some form of resupply of materials. Clicking on the text displays a definition of the term. Checking this box will allow the user to generate a line 5 of the request.
- (4) **“Maintenance” CheckBox.** This box is checked by the user to indicate that he needs some form of maintenance support from higher headquarters. Clicking on the text displays a definition of the term. Checking the box will allow the user to generate a line 6 of the request.

(5) **“Vehicle Recovery” CheckBox.** This box is checked by the user to indicate that he needs support from higher headquarters to recover a vehicle that his unit is not able to recover by itself. Clicking on the text displays a definition of the term. Clicking on the box will allow the user to generate a line 7 of the request.

(6) **“Engineer Support” CheckBox.** This box is checked by the user to indicate that he needs some form of engineering support. Clicking on the text will describe some of the services available. Clicking on the box will allow the user to generate a line 8 of the request.

(7) **“Pax/Cargo Movement” CheckBox.** This box is checked by the user to indicate that he needs support from higher headquarters to move personnel (Pax) or cargo. Clicking on the text displays a definition of the term. Clicking on the box will allow the user to generate a line 9 of the request.

(8) **Line 3 Preview.** Initially this has a red background to indicate to the user that he is not done completing the necessary information. Upon pressing any of the checkbox buttons, the color changes from red to green. If all of the checkboxes are deselected, the background color changes back to red and the text displays as “Line 3: Not Entered.”

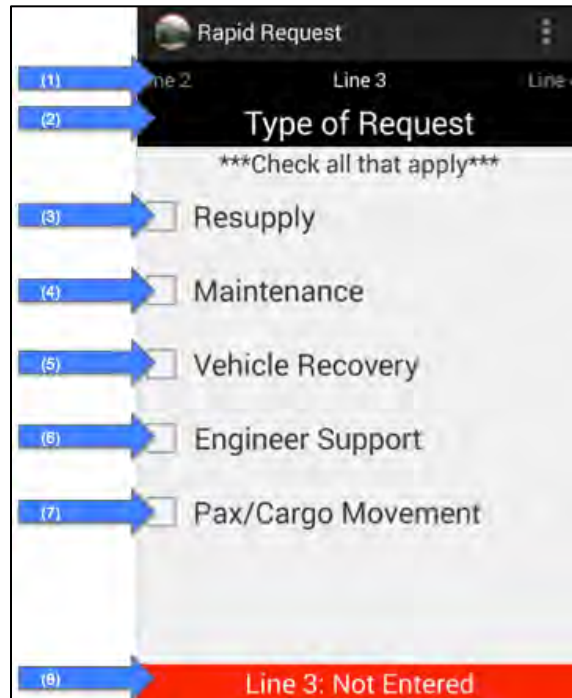


Figure 54. Rapid Request Line 3 Prior to User Input

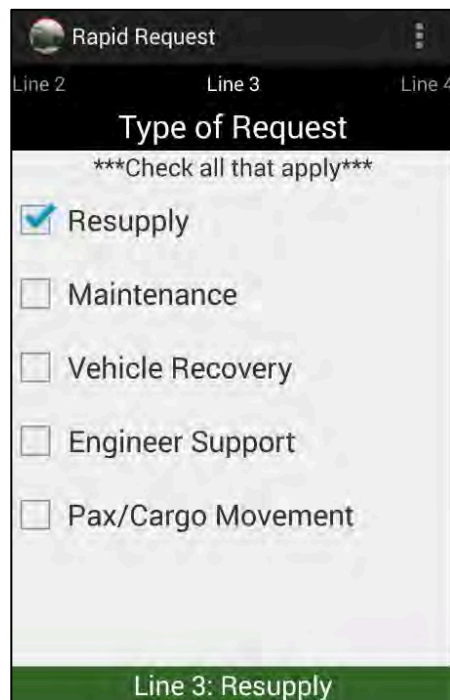


Figure 55. Rapid Request Line 3 After User Input

e. Line 4: Coordinating Instructions

The purpose of line 5 is to provide timing and location information to higher headquarters. The screen breaks down the line into the following areas:

- (1) **Navigation Bar.** Same as previous description.
- (2) **Line Title.** Same as previous description.
- (3) **“As Soon as Possible” Radio Button.** This button is selected when there is no specific time the support is needed. This lets the supporting headquarters know to try and fulfill the request as soon as possible with no specific time needed.
- (4) **“DTG” Radio Button.** This button is selected when the support is needed at a particular time. This will generally be used when the support is needed at a specific time because of unit movement. For example, the request might be for a fuel resupply on a specific point in a convoy mission. The unit commander can estimate that the unit will arrive at a particular time, thus minimizing the security risk to the refueling unit due to loitering.
- (5) **“Use GPS” Radio Button.** This is selected when the requesting unit needs support at its current position.
- (6) **“Manual Input” Radio Button.** This is used when the support is needed at a location that is different than the unit’s current position. In the previous example of a refueling request, the location might be given at a point along the convoy route.
- (7) **“Location” EditText.** This field allows the user to input a location (Latitude/Longitude or MGRS) where the support is needed.
- (8) **“Other Information” EditText.** This field is used to input any information about the request that is not included anywhere else in the application.
- (9) **Line 4 Preview.** Initially this has a red background to indicate to the user that he is not done completing the necessary information. Upon selecting both a time and location, the color changes from red to green.

Rapid Request

Line 3 Line 4

Coordinating Instructions

Time Needed

(3) ☐ As Soon As Possible

(4) ☐ DTG DD TTTT Zone MMM YY

Location Of Request

(5) ☐ Use GPS

(6) ☐ Manual Input

(7) Lat/Long or MGRS

Other Information

(8) Enter any amplifying information about the support needed that is not included anywhere else on this request.

(9) **Line 4: Not Entered**

Figure 56. Rapid Request Line 4 Prior to User Input

Rapid Request

Line 3 Line 4 Line 5

Coordinating Instructions

Time Needed

☒ As Soon As Possible

☐ DTG DD TTTT Zone MMM YY

Location Of Request

☐ Use GPS

☒ Manual Input

18S TU 135 485

Other Information

Enter any amplifying information about the support needed that is not included anywhere else on this request.

Line 4: Time Needed- ASAP, Location- 18S TU 135 485

Figure 57. Rapid Request Line 4 After User Input

*f. **Line 5: Resupply***

Line 5 will be available to populate is the user indicates “Resupply” as a type of request in line 3. The screen breaks down the line into the following areas:

(1) **Navigation Bar.** Same as previous description.

(2) **Line Title.** Same as previous description.

(3) **“Class I” Checkbox.** This is selected when the requesting unit needs a resupply of food and/or water. A description of what is needed is input into the adjacent EditText field.

(4) **“Class II” Checkbox.** This is selected when the requesting unit needs a resupply of consumable supplies. The quantity and description (including National Stock Numbers if possible) is entered in the adjacent EditText.

(5) **“Class III” Checkbox.** This is selected when the requesting unit needs a fuel resupply. A description of the amount and type needed is input into the adjacent EditText field.

(6) **“Class IV” Checkbox.** This is selected when the requesting unit needs construction materials. A description of the amount and type needed is input into the adjacent EditText field.

(7) **“Class V” Checkbox.** This is selected when the requesting unit needs additional ammunition. The quantity and description (including Department of Defense Identification Code if possible) is entered in the adjacent EditText field.

(8) **“Class VIII” Checkbox.** This is selected when the requesting unit needs additional medical supplies. The quantity and description (including National Stock Numbers if possible) is entered in the adjacent EditText.

(9) **“Class IX” Checkbox.** This is selected when the requesting unit needs repair parts. The quantity and description (including National Stock Numbers if possible) is entered in the adjacent EditText.

(10) **Line 5 Preview.** Initially this has a red background to indicate to the user that he is not done completing the necessary information. Upon selecting both a category and description, the color changes from red to green.

Rapid Request

Line 4 Line 5 Line 6

Resupply

Class	Item(s)/Quantity Needed
<input type="checkbox"/> I	Food/Water
<input type="checkbox"/> II	Consumables
<input type="checkbox"/> III	Fuel
<input type="checkbox"/> IV	Construction Materials
<input type="checkbox"/> V	Ammunition
<input type="checkbox"/> VIII	Medical Supplies
<input type="checkbox"/> IX	Repair Parts

(10) **Line 5: Not Entered**

Figure 58. Rapid Request Line 5 Prior to User Input

Rapid Request

Line 4 Line 5 Line 6

Resupply

Class	Item(s)/Quantity Needed
<input checked="" type="checkbox"/> I	3 DOS Chow/Water
<input type="checkbox"/> II	Consumables
<input checked="" type="checkbox"/> III	1500 Gallons JP8
<input type="checkbox"/> IV	Construction Materials
<input type="checkbox"/> V	Ammunition
<input type="checkbox"/> VIII	Medical Supplies
<input type="checkbox"/> IX	Repair Parts

Line 5: Class I - 3 DOS Chow/Water, Class III - 1500 Gallons JP8

Figure 59. Rapid Request Line 5 After User Input

g. Line 6: Maintenance Contact

Line 6 will be available to populate is the user indicates “Maintenance Contact” as a type of request in line 3. The screen breaks down the line into the following areas:

- (1) **Navigation Bar.** Same as previous description.
- (2) **Line Title.** Same as previous description.
- (3) **“Equipment Needing Repair” EditText.** The user will populate this field with the nomenclature (and other information, depending on unit SOP) of the equipment that needs maintenance.
- (4) **“Problem Description” EditText.** The user will populate this field with a detailed description of the problem. This will assist the supporting headquarters direct the proper resources/personnel to the requesting unit.
- (5) **Line 6 Preview.** Initially this has a red background to indicate to the user that he is not done completing the necessary information. Upon populating the equipment nomenclature and problem description, the color changes from red to green.



Figure 60. Rapid Request Line 6 Prior to User Input

The screenshot shows a mobile application interface titled "Rapid Request". At the top, there are three tabs labeled "Line 5", "Line 6", and "Line 7", with "Line 6" being the active tab. Below the tabs, the screen is divided into sections. The first section is titled "Maintenance Contact" and contains the text "Equipment Needing Repair" and "HMMWV SERNO 12357". The second section is titled "Problem Description" and contains the text "Starter INOP. Battery is fully charged, but will not turn over." At the bottom of the screen, there is a green bar with white text that reads: "Line 6A: HMMWV SERNO 12357" and "Line 6B: Starter INOP. Battery is fully charged, but will not turn over."

Figure 61. Rapid Request Line 6 After User Input

h. Line 7: Vehicle Recovery

Line 7 will be available to populate is the user indicates "Vehicle Recovery" as a type of request in line 3. The screen breaks down the line into the following areas:

- (1) **Navigation Bar.** Same as previous description.
- (2) **Line Title.** Same as previous description.
- (3) **"Vehicle Needing Recovery" EditText.** The user will populate this field with the nomenclature (and other information, depending on unit SOP) of the vehicle that needs recovery.
- (4) **"Problem Description" EditText.** The user will populate this field with a detailed description of the issue that resulted in the need for recovery. This will assist the supporting headquarters direct the proper resources/personnel to the requesting unit.
- (5) **Line 7 Preview.** Initially this has a red background to indicate to the user that he is not done completing the necessary information. Upon populating the nomenclature and problem description, the color changes from red to green.



Figure 62. Rapid Request Line 7 Prior to User Input

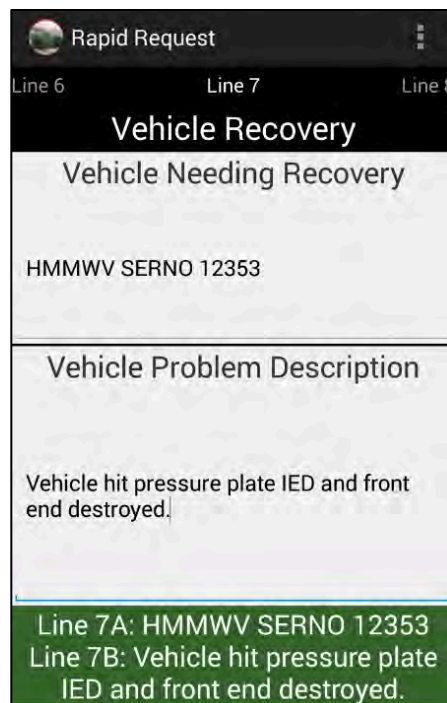


Figure 63. Rapid Request Line 7 After User Input

i. Line 8: Engineer Support

Line 8 will be available to populate is the user indicates “Engineer Support” as a type of request in line 3. The screen breaks down the line into the following areas:

- (1) **Navigation Bar.** Same as previous description.
- (2) **Line Title.** Same as previous description.
- (3) **“Mobility” Radio Button.** The user will select this radio button if he needs mobility support from a supporting engineering unit. Mobility includes obstacle reduction by maneuvering and engineer units to reduce or negate the effects of existing or reinforcing obstacles. The objectives are to maintain freedom of movement for maneuver units, weapon systems, and critical supplies [32].
- (4) **“Counter Mobility” Radio Button.** The user will select this radio button if he needs counter-mobility support from a supporting engineering unit. Counter-mobility includes the construction of obstacles to delay, disrupt, and destroy the enemy by reinforcement of the terrain [32].
- (5) **“Survivability” Radio Button.** The user will select this radio button if he needs assistance increasing the survivability of a position from a supporting engineering unit. Survivability includes all aspects of protecting personnel, weapons, and supplies while simultaneously deceiving the enemy. This encompasses planning and locating position sites, designing adequate overhead cover, analyzing terrain conditions and construction materials, selecting excavation methods, and countering the effects of direct and indirect fire weapons [32].
- (6) **“Horizontal Construction” Radio Button.** The user will select this radio button if he needs assistance with any form of horizontal construction from a supporting engineering unit. This includes the construction required to shape the terrain to meet the operational requirements of the unit. The requirements include, but are not limited to: Main Supply Route (MSR) Construction, Expeditionary Airfields, Site Preparations for Static Positions and Ordnance Storage Facilities [32].
- (7) **“Vertical Construction” Radio Button.** The user will select this radio button if he needs assistance with any form of vertical construction from a supporting engineering unit. Vertical construction is the improvement or construction of

facilities for use by a unit. These facilities can be used in base camps, command posts, and maintenance facilities. Types of vertical construction include: Wood and Masonry Structures, Existing Facility Rehabilitation, and Structural Reinforcement [32].

(8) **“Other” Radio Button.** This is selected by the user when he needs another service not listed in the five previous categories.

(9) **“Support Needed” EditText.** The user will populate this field with a description of what service he needs.

(10) **Line 8 Preview.** Initially this has a red background to indicate to the user that he is not done completing the necessary information. Upon selecting both a category and description, the color changes from red to green.

The image shows a mobile application interface titled "Rapid Request". It features a list of radio buttons under the heading "Engineer Support". The options are: Mobility, Counter Mobility, Survivability, Horizontal Construction, Vertical Construction, and Other. Below this list is a text input field labeled "Support Needed" with a placeholder text "Provide a brief description of the support you need." At the bottom, there is a red bar with the text "Line 8: Not Entered". Blue arrows with numbers (1) through (10) point to various elements: (1) points to the top bar, (2) to the Engineer Support header, (3) to the Mobility radio button, (4) to the Counter Mobility radio button, (5) to the Survivability radio button, (6) to the Horizontal Construction radio button, (7) to the Vertical Construction radio button, (8) to the Other radio button, (9) to the Support Needed text field, and (10) to the red Line 8 preview bar.

Figure 64. Rapid Request Line 8 Prior to User Input

The screenshot shows a mobile application interface titled 'Rapid Request'. At the top, there are three tabs: 'Line 4', 'Line 8' (which is active), and 'Line 9'. Below the tabs is a section titled 'Engineer Support'. This section contains a list of radio buttons: 'Mobility' (selected), 'Counter Mobility', 'Survivability', 'Horizontal Construction', 'Vertical Construction', and 'Other'. Below this list is a section titled 'Support Needed' which contains a text input field with the text 'Obstacle reduction IVO Company CP'. At the bottom of the screen is a green bar with white text that reads 'Line 8: MOBILITY - Obstacle reduction IVO Company CP'.

Figure 65. Rapid Request Line 8 After User Input

j. Line 9: Pax/Cargo Movement

The purpose of line 9 is provide information about any personnel or cargo that requires non-organic transportation. The screen breaks down the line into the following areas:

- (1) **Navigation Bar.** Same as previous description.
- (2) **Line Title.** Same as previous description.
- (3) **“Pax” Count.** Here, the user will indicate the number of personnel requiring transport.
- (4) **“Cargo Pounds” EditText.** The user will populate this field with the number of pounds in any load of cargo he or she wishes to move.
- (5) **“Additional Cargo Information” EditText.** The user will select populate this field with amplifying information about the cargo to be lifted. This will help higher headquarters dispatch the appropriate vehicles and equipment to move the cargo.
- (6) **“Destination” EditText.** The user will populate this field with a location for the personnel or cargo to be delivered.

(7) **Line 9 Preview.** Initially this has a red background to indicate to the user that _he is not done completing the necessary information. The required fields for this line are a destination and number of pax and/or cargo weight and description. Upon populating the required information, the color changes from red to green.

The screenshot shows the 'Rapid Request' app interface. At the top, there's a header with 'Rapid Request' and a 'Review' button. Below the header, there are two tabs: 'Line 8' and 'Line 9'. The 'Line 9' tab is selected. The main section is titled 'Pax/Cargo Movement'. It contains several input fields: a 'Pax' field with a red minus button, a numeric input field showing '0', and a green plus button; a 'Cargo Pounds' field with a placeholder 'ex: 1000lbs'; an 'Additional Cargo Information' field with a placeholder 'ex: 4 pallets of small arms ammo'; and a 'Destination' field with a placeholder 'ex: 18SPU123456 or 'FOB Lion''. At the bottom, there's a red bar with the text 'Line 9: Not Entered'. Blue arrows with numbers (1) through (7) point to the following elements: (1) Line 8 tab, (2) Line 9 tab, (3) Pax/Cargo Movement title, (4) Cargo Pounds field, (5) Additional Cargo Information field, (6) Destination field, and (7) Line 9: Not Entered bar.

Figure 66. Line 9 Prior to User Input

The screenshot shows a mobile application interface for 'Rapid Request'. At the top, there's a header bar with a globe icon, the text 'Rapid Request', and a menu icon. Below this, a navigation bar shows 'Line 8', 'Line 9' (which is highlighted), and 'Review'. The main content area is titled 'Pax/Cargo Movement'. It contains several input fields: a red minus button, a text box with the number '2', a green plus button, and the label 'Pax'. Below this is a 'Cargo Pounds' field with the value '1000'. An 'Additional Cargo Information' section contains the text '1 Pallet Small Arms'. A 'Destination' section contains the text 'FOB Green'. At the bottom, a green summary bar displays the following text: 'Line 9: Pax - 2, Cargo Weight - 1000, Cargo Description - 1 Pallet Small Arms, Destination - FOB Green'.

Figure 67. Rapid Request Line 9 After User Input

k. Final 9-Line

The purpose of the final line is to provide the user with a chance to review his or her inputs and send the request by his or her preferred method (digital or voice). The screen breaks down the line into the following areas:

- (1) **Navigation Bar.** Same description as previous.
- (2) **Line Title.** Same description as previous.
- (3) **Line Description.** Instructs the user to review the information in the 9-Line and press the “Digital” button to transmit digitally or “Voice” button to display the voice transmission format.
- (4) **Line Data.** This is the plaintext version of the user’s input that was used to populate the lines. This is in plain English vice line data format for ease of review by the user. The data is properly formatted prior to digital transmission or display to the user for voice transmission.

(5) **“Digital” Image Button.** This puts some connectivity information and line data into an array for transmission to the sender’s higher headquarters. The information is sent as a string array containing the following:

- Index 0: The string “RAPIDREQUEST.” The distant end uses this string for identifying what type of message is being received.
- Index 1: String containing the plaintext unit title to inform the supporting headquarters from whom the Rapid Request is originating.
- Index 2: String containing the Internet protocol (IP) address of the sending device. This is used for the distant end to acknowledge receipt.
- Index 3: String containing line 1.
- Index 4: String containing line 2.
- Index 5: String containing line 3.
- Index 6: String containing line 4.
- Index 7: String containing line 5.
- Index 8: String containing line 6.
- Index 9: String containing line 7.
- Index 10: String containing line 8.
 - Index 11: String containing line 9

(6) **“Voice” Image Button.** This button displays the 9-Line in proper format for digital transmission. This is used when there is no data network connectivity.

(7) **Final 9-Line Indicator.** Initially this has a red background to indicate to the user that he has not transmitted the 9-Line to his higher headquarters. Upon pressing the “Digital” button, the application transmits the data array to the IP address and port as indicated in the preset settings. Upon receipt by the user’s higher headquarters, an acknowledgement message is sent back and the background color changes to green and the text changes to “Acknowledged By Server.”

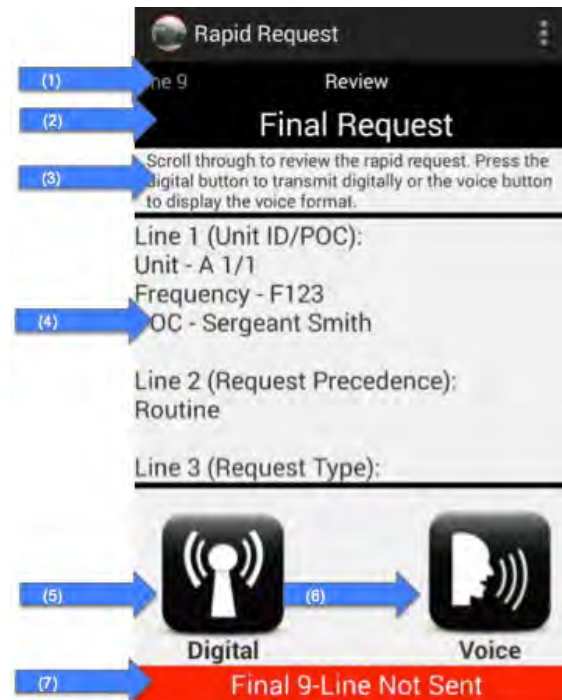


Figure 68. Rapid Request 9-Line Review

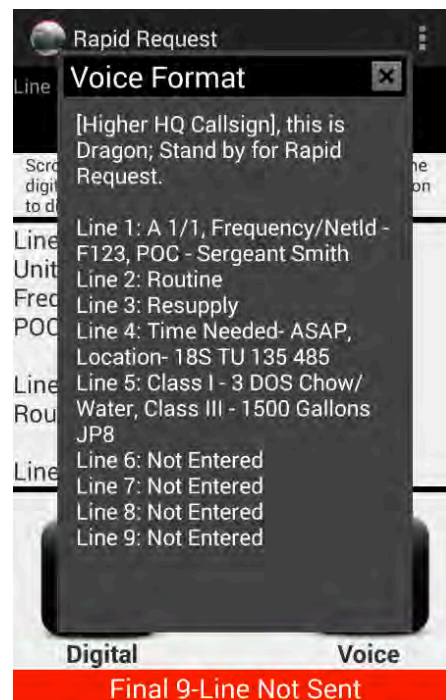


Figure 69. Rapid Request Voice Format

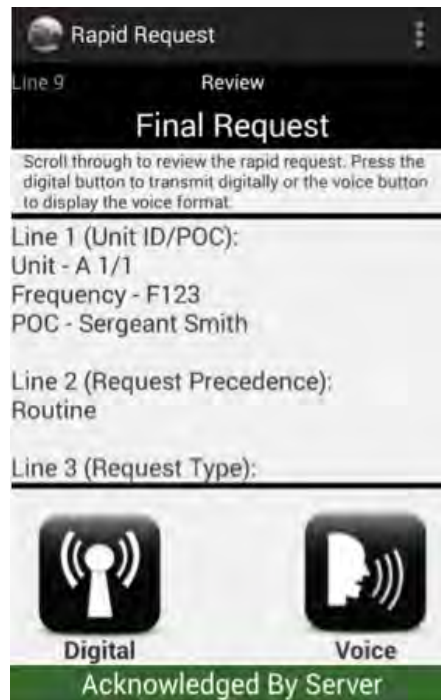


Figure 70. Rapid Request Final 9-Line After Digital Transmission

IV. TESTING AND DEVELOPMENT

A. OVERVIEW OF TESTING

We chose to test only the CASEVAC application instead of all three applications that make up the entire HELP suite of applications. The reason for testing just the CASEVAC application was to focus our limited time and energy on getting the best design for one application which flows through the other three applications. Most design issues discovered in the CASEVAC application would easily translate to the other applications as all three applications are very similar in design. Another reason we decided to test the CASEVAC application is because it provides the best proof of concept for a hand-held device used to request support in stressful conditions. Of all three of our applications, the users of the CASEVAC application would be under most stress; the speed and accuracy with which users can submit the MEDEVAC 9-Line request could be the difference between life and death.

B. APPLICATION PURPOSE AND GOAL REMINDER

1. Purpose

The overall purpose of our CASEVAC application is to enable a user of any skill level, in a stressful environment, to correctly submit a Medical Evacuation 9-Line request to the appropriate higher headquarters in a quick and efficient manner.

2. Goals

The individual goals of the CASEVAC application are listed below:

- Easy enough that an individual needs minimal to no training before using the application.
- Help guide and direct the user through the process by providing helpful hints and shortcuts when filling out the 9-Line information.
- Make use of built-in sensors to speed-up the process of completing the request.
- Assist the user in submitting the request even if there is no connection or digital connection to higher units.

- Prevent common user errors.

C. USABILITY TESTING AND DATA COLLECTION

1. Testing Phases

We took a phased approach to testing the CASEVAC application instead of conducting the very first test in a realistic environment with simulated casualties. We broke the testing down into three separate phases (initial, intermediate, field) and we completed the first two tests but did not get the opportunity to do the third test because of time constraints. The phases of testing are as follows:

a. Initial Test

The purpose of this test was to determine the best design layout for the CASEVAC application and how to prevent errors by the user under non-stressful conditions and identify areas in the user interface for improvement and redesign.

b. Intermediate Test

The purpose of this test was to evaluate the ease of use and the effectiveness of the CASEVAC application when a user is exposed to low to medium levels of stress in a laboratory environment and identify areas in the user interface for redesign. Testing was also done to determine the size of the data packet that was sent from the application to the server.

c. Field Test

The purpose of this test is to discover the effectiveness and efficiency of the application and the user's satisfaction with the application in a high stress environment in which the application would be used. This test should to be conducted in an environment similar to an Infantry Immersion Trainer in which the user is exposed to as realistic conditions as possible to test the CASEVAC application against traditional means of submitting a MEDEVAC request.

2. Data Collection Methods

For the two tests that we conducted the means for data collection was very similar. In the initial test we used a combination of on-site observation and two survey questionnaires to capture qualitative data. For quantitative data, we used code within the application to record the time the user spent on each screen, their navigation sequence, total clicks, and the total time to complete the MEDEVAC request. Lastly, we used WireShark to capture data packets to determine the size of the transmission by the CASEVAC application to the server.

Survey 1 (Appendix D) contained a total of 20 questions broken down into 4 categories to collect qualitative data. The categories were: Appearance, Ease of Use, Error Handling, and Overall Impression. The users, after using the CASEVAC application, answered each question using a simple Likert scale from 1–5 (1-Strongly Disagree and 5-Strongly Agree). Survey 2 (Appendix C) contained 5 questions to get basic information from the user and 7 short answer questions to get more detailed feedback about the application from the user.

3. Android Device Used

The Android device that was used in the first two testing phases was the Samsung Galaxy Nexus, which was released in 2011 for a cost of approximately \$700.00; however, three years later the device is selling for around \$120. Other key specifications of the device are shown in Table 1 [33], [34].

Samsung Galaxy Nexus Key Specifications	
Display Screen	4.65 in.
Weight	5.1 oz.
Operating System	4.0 Ice Cream Sandwich (released Oct/2011)
Battery Life	Approximately 6 days stand by, 12 hours talk
Form Factor	Touchscreen
Camera	Front and Rear
Connectivity	802.11, Bluetooth
Central Processing Unit (CPU)	1.2GHz Dual-core, OMAP, TI
Ruggedized	No

Table 1. Samsung Galaxy Nexus Key Specifications, after [31]

This phone was chosen for two reasons. First, the phone was cheap. The second reason was that we wanted to prove that the application did not need a high-end device to run. Currently, Android is using 4.4 Kit Kat operating system, which is the fifth update to its operating system since the Galaxy Nexus was released [35]. We wanted to demonstrate that a cheap, older smartphone considered to be out-of-date is still capable of meeting the military's needs.

D. INITIAL TEST

The initial testing focused on the layout and error prevention in the CASEVAC application. The testing set-up and users' background for the initial testing are discussed below.

1. Testing Set-Up Round 1

For this test, all users were given a five-minute demonstration of the basic functions of the phone, and how to navigate the HELP Settings and CASEVAC applications. After the demonstration the users were given a two-page scenario (Appendix A) and were required to complete a MEDEVAC 9-Line request based on the information provided in the scenario. After they completed the task of submitting the MEDEVAC 9-Line request with the CASEVAC application they were given two surveys to fill-out. It took approximately 30 minutes per user to complete the test.

2. Users' Background Round 1

While the end target users are junior service members with little to no training on MEDEVAC 9-Line request, the opportunity and access to those individuals during this phase did not exist. However, with the Initial Test focusing on ease of use and appearance, this was not a big problem with the population available at the Naval Postgraduate School. Many of the students here have very similar characteristics that are important in testing the application. The most important characteristics both groups share are that some members have experience with MEDEVAC 9-Line requests while others do not. The key to selecting the individuals for the Initial Test was to ensure we had individuals with various skill levels on MEDEVAC requests.

We tested with a total of four individuals for this phase drawn from every service but the Air Force. They had a range of time in service between 6–18 years with the average being 12 years. Their self-proclaimed experience level on MEDEVAC 9-Line request the average was 3.5 on a scale of 1 to 5, which is a little above formal training.

3. Initial Test Results Round 1

The timing and survey results from initial testing for Round 1 are provided below.

a. Time

While the total time to complete the MEDEVAC request was not the main objective of this phase, we recorded the time to complete the request using the application with a stop watch. We started the time when the user opened the CASEVAC application and stopped the watch when the users reached the “submit screen.” During the Initial Testing Phase we saw an average of 165 seconds with a range of 118–197 seconds.

b. Survey 1 Results Round 1

Figure 71 shows the total score for Survey 1, which the average score was 94.75 out of 100. Figure 72 shows the average score for the four different categories in Survey 1.

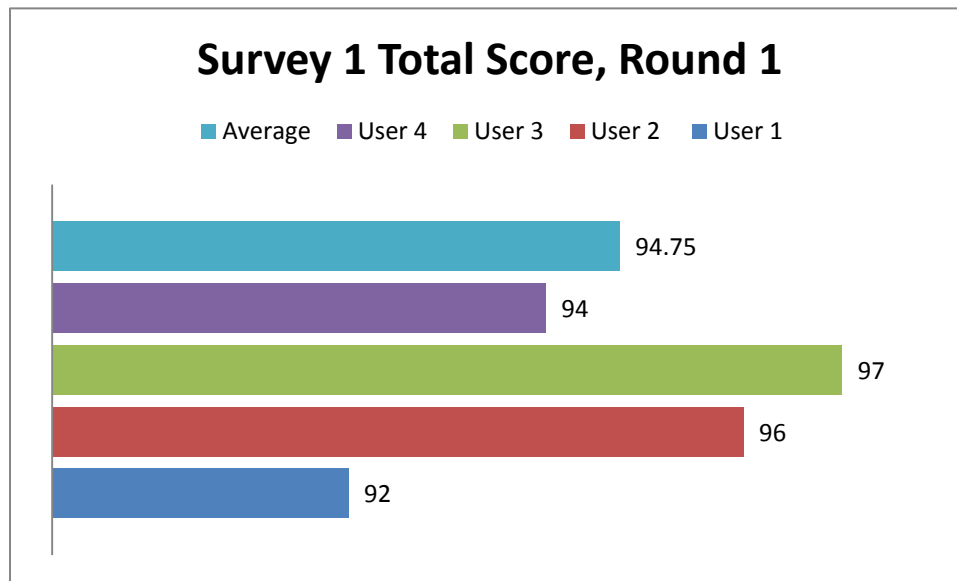


Figure 71. Survey 1 Total Score, Round 1

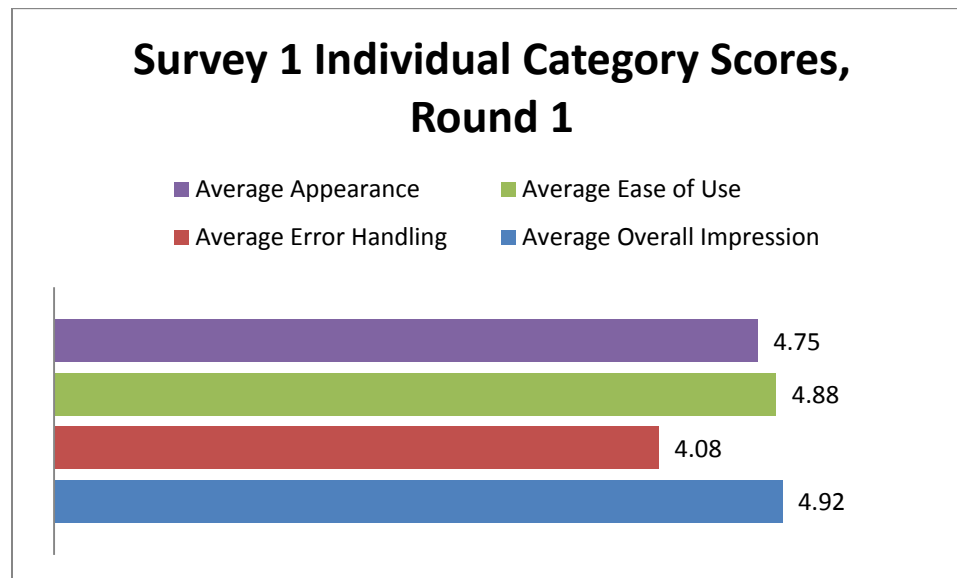


Figure 72. Survey 1 Individual Category Scores, Round 1

c. Survey 2 Results Round 1

Selected comments from Survey 2 in Round 1:

(1) Liked features-

“Auto fill in ...”

“Easy to quickly move through required data entry”

(2) Disliked features-

“Increment button [was] a little too close”

“it was a little hard to see the default information to enter of the initial screen [HELP]”

“Needs more separation between fields in Lines 1 and 2...”

(3) Need to add to application-

“Reset form button”

“Need to increase the size of the total number of casualties to reference when filling out line 5...”

“Camera is a great idea since there is some difference of opinions in classifying casualties”

E. ANALYSIS AND REDESIGN AFTER INITIAL TEST, ROUND 1

The analysis of Round 1 testing and redesign implemented based off of observation and user feedback are discussed below.

1. Analysis

Overall, the system results were positive and provided valuable feedback. We had an average of 4 on the Likert scale in all categories for Survey 1. However, the most important feedback that we received was from the comments on Survey 2. The comments gave us areas in the application that the layout or graphics could be adjusted to make the application more user friendly. Furthermore, several ideas for adding functionality were suggested that we did not originally consider during development. Finally, completion times between individuals with different experience levels were relatively close, which shows that the CASEVAC application is able to be used independent of experience level. Finally, even with the positive feedback, we felt that at least another round in the Initial

Test was needed since the pool of users was small and to test the areas that we redesigned.

2. Redesign

Because of the overall positive feedback from the users we decided that we were not going to make any major changes to the design of the application, but integrate some of the layout modifications that the users suggested. These included enlarging several of the buttons on various screens and an increase in font size on multiple screens. Furthermore, after observing the users during the tests, we decide it would be best to add in haptic feedback into the application. So anytime when the user presses a button or makes a selection there is vibration to provide feedback to the user that the button was pressed.

a. HELP Settings Redesign

It was suggested that we redesign the layout of the HELP Settings application because it was difficult to see what the user had entered. Keeping this in mind, we changed the HELP Settings application to increase the size of the text to make information easier to read. Furthermore, we changed the color of the text when the users entered information to help make it easier for the user to see. The before and after screen shots can be seen in Figures 73, 74, and 75.



Figure 73. HELP Settings Prior to Redesign

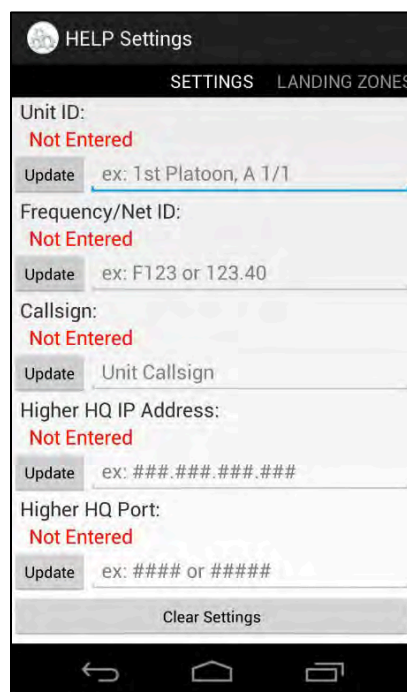


Figure 74. HELP Settings After Redesign



Figure 75. HELP Settings After User Input

b. Screen/Line 1 GPS Button Redesign

During observation we noticed that some of the users seemed to search for the GPS button on Screen/Line 1 of the MEDEVAC request. In order to reduce the time needed to find the button we made the GPS button larger to take up more screen space. The before and after screen shots can be seen in figures 76 and 77.

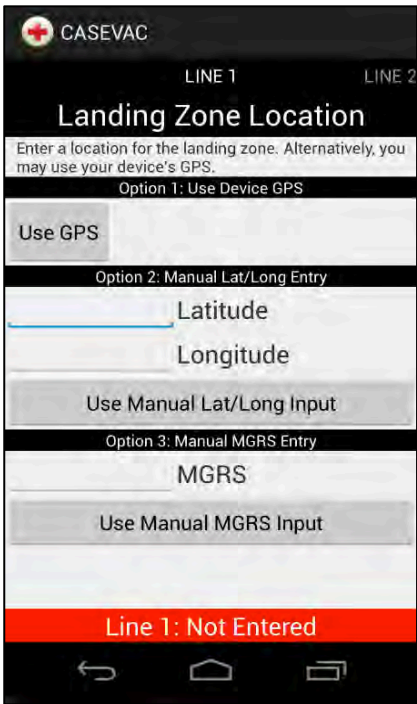


Figure 76. CASEVAC Line 1 Before Initial Redesign

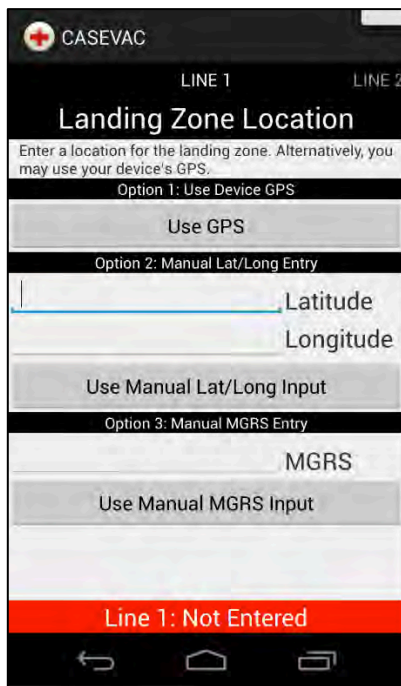


Figure 77. CASEVAC Line 1 After Initial Redesign

c. Screen/Line 2 Preset Button Redesign

During observation and feedback provided by the users, we determined that the preset button on Screen/Line 2 had the same problem as the GPS button on Line 1. Again, we increased the size of the button to take up more screen real estate to make it easier to find. Furthermore, we moved the saved preset information above the preset button, to help draw the user's eyes. The before and after screen shots can be seen in Figures 78 and 79.

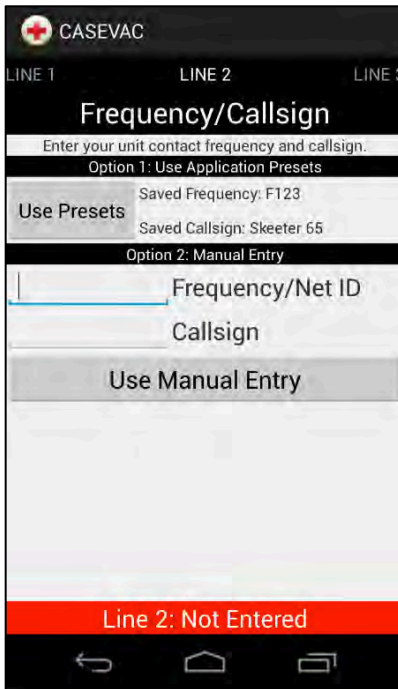


Figure 78. CASEVAC Line 2 Prior to Initial Redesign

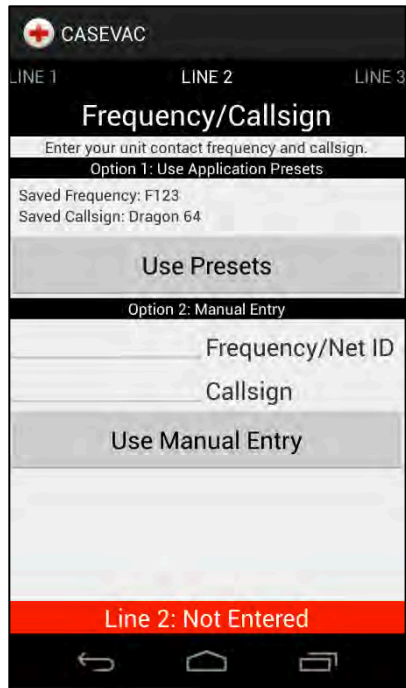


Figure 79. CASEVAC Line 2 After Initial Redesign

d. Screen 10/Final Review Redesign

Like the previous two changes, the “Send to Higher Headquarters” button was determined to be too small based on feedback and observation and that it should be made larger. We increased the size of the button to make it take up more real estate on the screen to make it easy to see and press. The before and after screen shots can be seen in Figures 80 and 81.

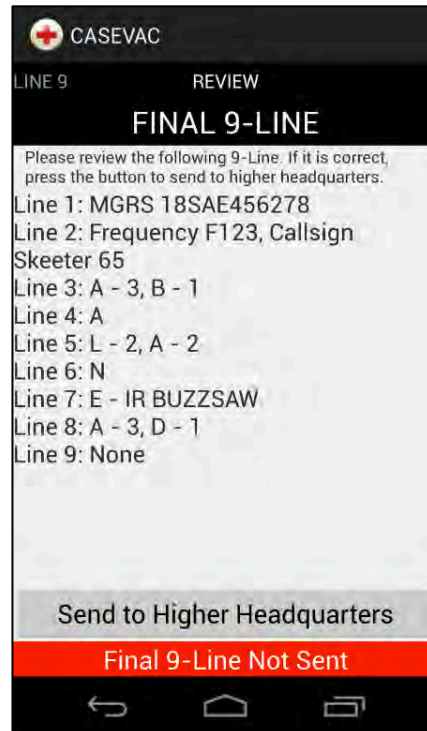


Figure 80. CASEVAC Final Review Screen Prior to Initial Redesign

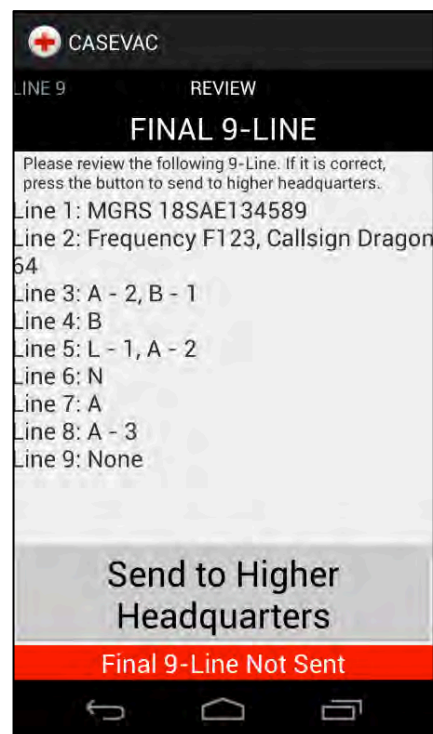


Figure 81. CASEVAC Final Review After Initial Redesign

F. TEST SET-UP INITIAL TEST, ROUND 2

For Round 2 in the Initial Test all users, which were different from Round 1, where given the same five minute demonstration on basic functions of the phone, and how to navigate the HELP Settings and CASEVAC applications as in Round 1. After the demonstration the users were given the same two page scenario (Appendix A) and were required to complete a MEDEVAC 9-Line request based on the information provided in the scenario. After they completed the task of submitting the MEDEVAC 9-Line request with the CASEVAC application they were given two surveys to answer. In Round 2 we wanted to capture more data than in the first round. To do this we implemented code within the CASEVAC application to capture the number of keystrokes (Figure 82), and the time spent on each screen. This additional information helped highlight areas within the application that could be improved, which could not be captured by surveys or observation. The total time to test each user took approximately 30 minutes.

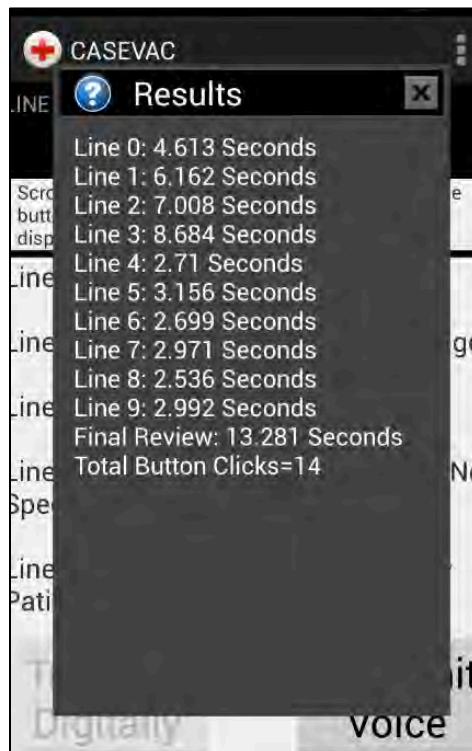


Figure 82. CASEVAC Testing Result Example

1. Users' Background Round 2

Like Round 1, we were not able to get access to junior service members, but relied on students (military and civilian) at NPS. In addition, we doubled our number of users to test the application for this round. Their average self-proclaimed experience level on MEDEVAC-9 Line request was an average of 2.2, which is informal training level (Figure 83).

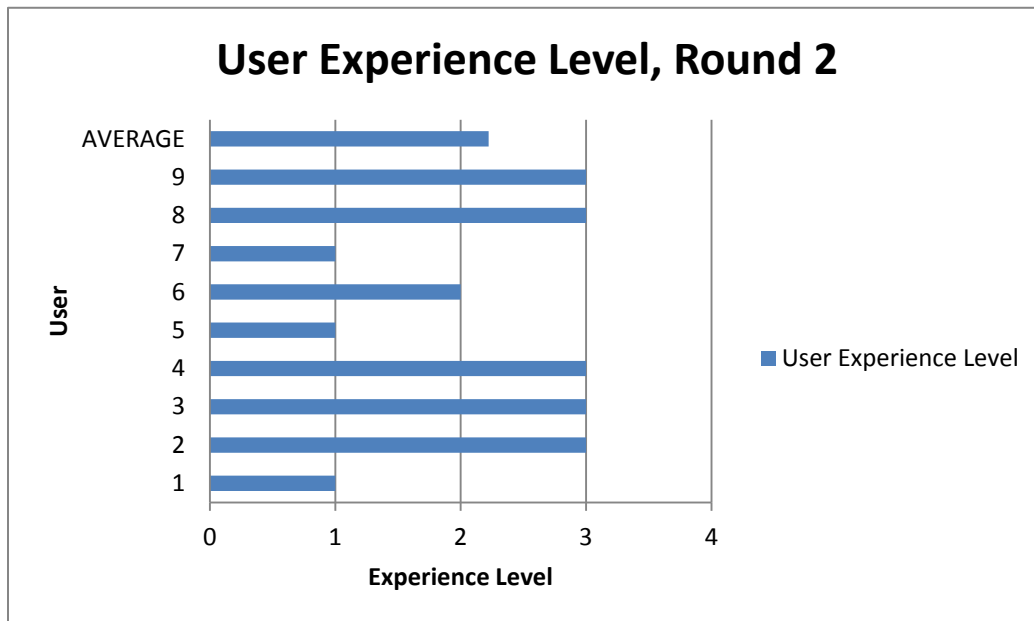


Figure 83. User Experience, Round 2

2. Initial Test Results Round 2

The timing and survey results from Round 2 of initial testing are discussed below.

a. Time and Total Clicks

Figure 84 shows the results for the average time spent per screen by each of the nine users. The longest time spent on any screen was Line 3, which is the precedence level of the casualties. Figure 85 shows the results of the total clicks per user and the total time to complete the scenario. The average for all users to complete the scenario was 150.7 seconds or 2 minutes and 20 seconds with a range between 72–269 seconds. The average total clicks were 35 with a range of 29–51 clicks.

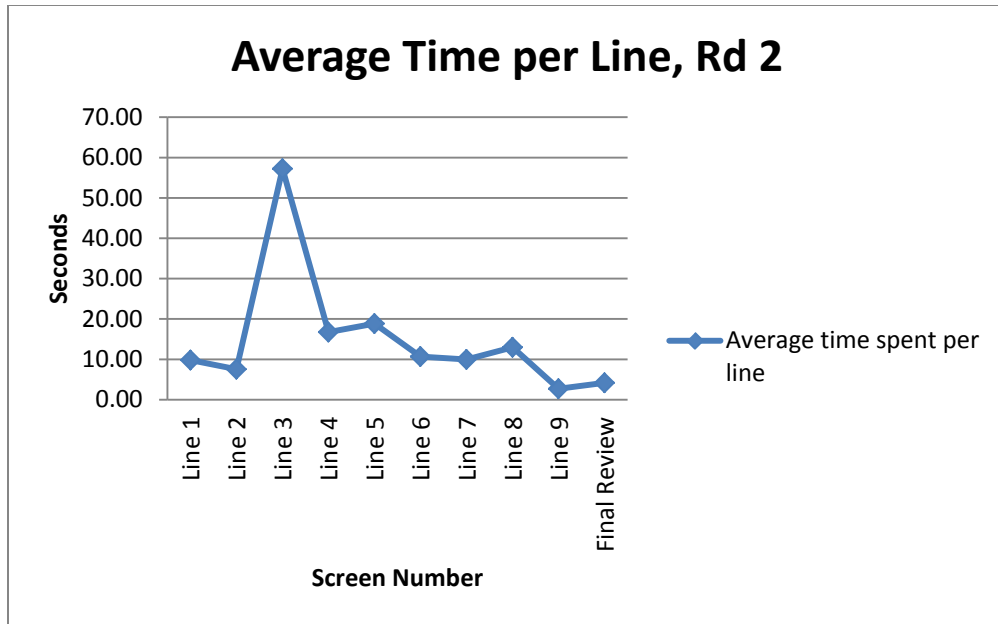


Figure 84. Average Time per Line, Round 2

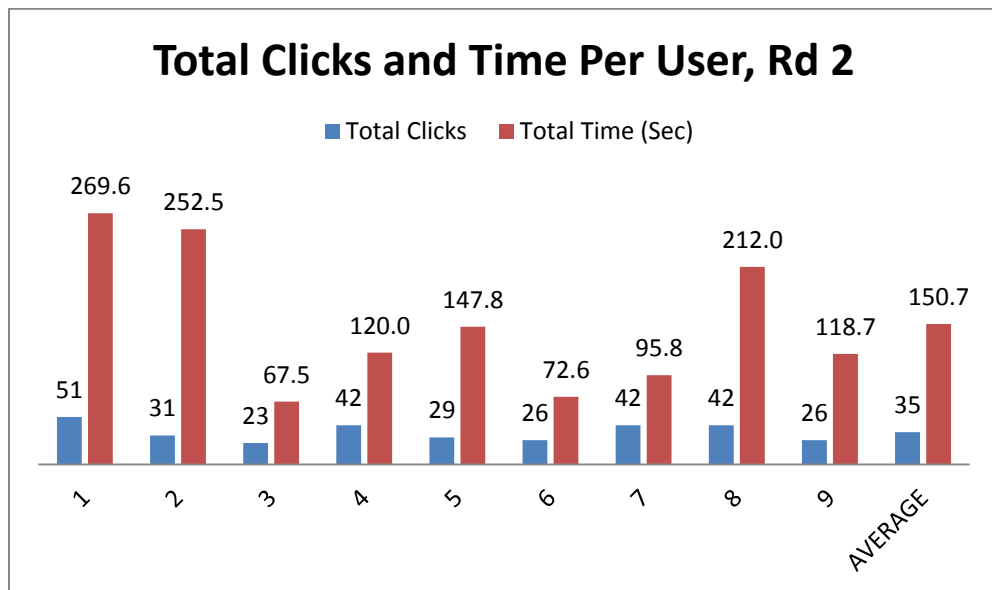


Figure 85. Total Clicks and Time per User, Round 2

b. Survey 1 Results Round 2

The average overall score for Survey 1 was 95.89 with a range 93–99, and per category range were 4.75–5.00; see results in Figure 86 and Figure 87.

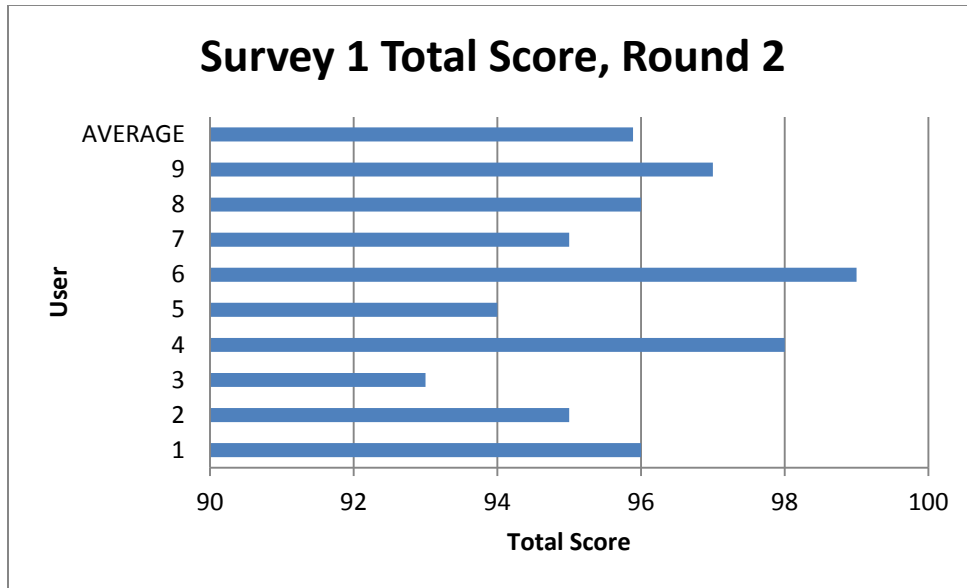


Figure 86. Survey 1 Total Score, Round 2

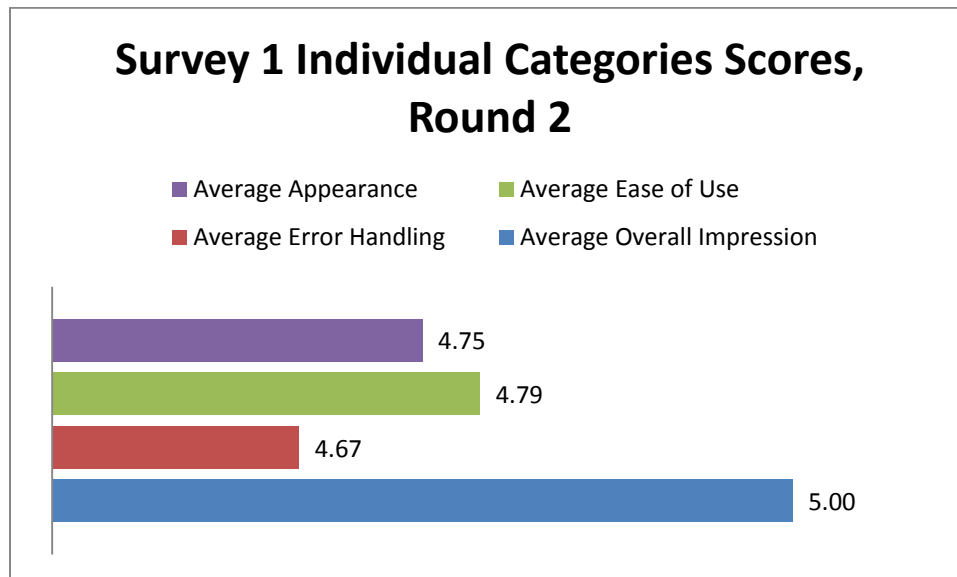


Figure 87. Survey 1 Individual Categories Scores, Round 2

c. Survey 2 Results Initial Testing Phase, Round 2:

Selected comments from Survey 2 the users:

(1) Liked Features

“Auto fill in ...”

“displaying one option line at a time, which helps guide the user through”
“GPS and pre-set feature”
“vibration response to entering information...”

(2) Disliked Features

“description of precedence levels, they need to be simpler”
“easy to fat-finger some screens...”

(3) Need to add to application

“Swipe arrow to help guide user...”
“Question mark to inform user of added help”
“ability to save or update information after transmission”

G. ANALYSIS AND REDESIGN AFTER ROUND 2

The analysis of Round 2 testing and redesign implemented based off of observation and user feedback are discussed below.

1. Analysis

Similar to Round 1, the test results for Round 2 were positive, and again, we gained valuable feedback from the nine users. As before, the goal for Survey 1 was an average 4 on the Likert scale which we easily achieved again in Round 2. Furthermore, we saw over half a point increase in the Error Handling category which helped validate that design changes we made after Round 1. Furthermore, there was a 15 second reduction in the time to generate the request, which further validates the redesign after Round 1. While the results from Survey 1 were positive, we were a little shocked to discover that total clicks did not have a stronger correlation between overall times. While there is a weak correlation with total clicks, we expected there to be a strong correlation with the longest times being the ones with the most clicks, which was not the case (Figure 85). For example we had three users with a total of 42 clicks but their times ranged from 95.7 seconds to 212.0 seconds, which translated into the second fastest time and the third slowest time. There are also several cases of fewer total clicks but a slower

time compared to more total clicks and faster time. While these results were unexpected, we cannot determine at this time with the information collected why this is the case.

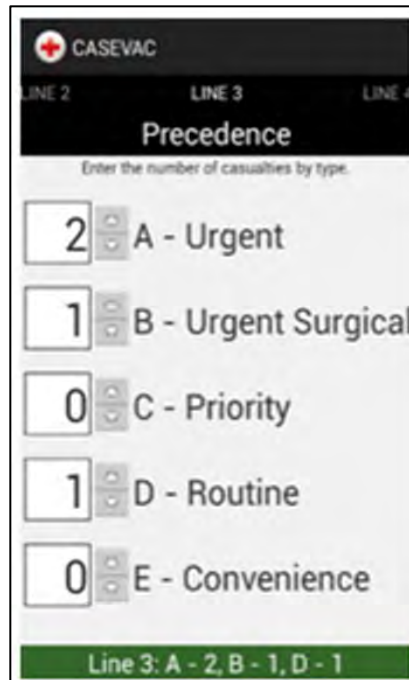
Overall, the result from Survey 1 and Survey 2 show that the CASEVAC application is feasible and applications can be used to call in requests for services. After the results from this round we felt that we could proceed to the Immediate Test.

2. Redesign

We chose to focus on two comments that appeared numerous times in Survey 2: “fat fingering” and “guiding the user.” We felt that focusing on these two areas after Round 2 would give us the greatest improvement to the CASEVAC application at this time.

a. Line 3/5/8 Redesign to Prevent “fat-fingering”

Selecting the wrong button or also known as “fat fingering” is always going to be a challenge with any application on a smart device because of the limited screen real estate, and with our application we have to take stress into consideration. In order to try to help eliminate “fat fingering,” we have decided that in almost every screen there is text that can be eliminated to free up screen real estate. For example; on Line 3, we removed the top line that gave directions to the user and we removed the radio abbreviations (A-Urgent, etc.) to make room for the buttons to be larger. (Figures 88–91) Another improvement to reduce the issue of “fat fingering” is adjusting the layout of the buttons. Before, all buttons were on the left side of the screen and the same color. We moved the location of the buttons so they are not located next to each other and provided as much space as possible between the two. Next, we color coded the buttons to provide a greater distinction between the two to help eliminate accidental selection of the wrong button.



CASEVAC
 LINE 2 LINE 3 LINE 4
Precedence
 Enter the number of casualties by type.
 2 A - Urgent
 1 B - Urgent Surgical
 0 C - Priority
 1 D - Routine
 0 E - Convenience
 Line 3: A - 2, B - 1, D - 1

Figure 88. CASEVAC Line 3 Prior to Redesign



CASEVAC
 LINE 2 LINE 3 LINE 4
Casualties by Precedence
 - 0 + Urgent
 - 0 + Urgent Surgical
 - 0 + Priority
 - 0 + Routine
 - 0 + Convenience
 Line 3: Not Entered

Figure 89. CASEVAC Line 3 After Redesign

CASEVAC

LINE 4 LINE 5 LINE 6

Number of Patients By Type

Indicate the number of patients by type. NOTE: You previously indicated in LINE 3 that there are a total of 4 casualties.

2 L - Litter

2 A - Ambulatory

Line 5: L - 2, A - 2

Figure 90. CASEVAC Line 5 Prior to Redesign

CASEVAC

LINE 4 LINE 5 LINE 6

Number of Patients By Type

NOTE: You previously indicated in LINE 3 that there are a total of 2 casualties.

− 2 + Litter

− 0 + Ambulatory

Line 5: L - 2

Figure 91. CASEVAC Line 5 After Redesign

b. Guiding the User

The testing brought to our attention that some users may not know how to navigate through the application, or may need definitions to help them guide in their decision making. To eliminate this, we added an additional screen at the beginning of the application. This screen is the first screen that user will see when the application is launched. It provides the user with basic instructions on how to navigate through the application and also that there are definitions to help guide them. We believe after using the application a few times or if the application comes with a training program that this screen could be eliminated. Until then, the “Welcome” screen will be needed for users who are unfamiliar with the application.



Figure 92. CASEVAC Welcome Screen

c. Redesign of the Final Review Screen

Upon reviewing the time spent per screen by the users, we noticed that the users spent a lot less time than expected reviewing their request before submitting. After some analysis, we was determined the “review” screen was too complex and provided little

information to an untrained user. It was too complex because we were trying to combine the final review and the back-up means of submitting the request on the same screen. The information presented to the user is what would need to be read to submit the request via voice; however, presenting the information this way did not give any reviewable information to an untrained user. This is because an urgent casualty is transmitted over the radio A-1, and an untrained user would not know what “A-1” meant. To correct this issue the “review” screen was redesigned to allow the user to review their request in plain language terms vice brevity codes. Now, there is an additional transmit button that will allow the user to display the voice format. If the user selects “digital” the application will function in the exact same way before the redesign, which is sending a request in the proper format digitally to the server. However, if the user selects “voice,” a pop-up screen will appear with the correct format needed to properly transmit the request over the radio.

The screenshot shows a mobile application interface for CASEVAC. At the top, there is a red cross icon and the text 'CASEVAC'. Below this, the word 'REVIEW' is centered. Underneath 'REVIEW' is the title 'FINAL 9-LINE'. A line of text reads: 'Please review the following 9-Line. If it is correct, press the button to send to higher headquarters.' Below this is a list of nine lines of information: Line 1: MGRS 18SAE143556, Line 2: Frequency F123, Callsign Dragon 64, Line 3: A - 2, B - 1, D - 1, Line 4: B, D, Line 5: L - 2, A - 2, Line 6: P, Line 7: E - Chemlight NATO Y, Line 8: A - 3, D - 1, and Line 9: None. At the bottom of the screen is a large grey button labeled 'Send to Higher Headquarters'. Below the button is a green bar with the text 'Acknowledged By Server'.

Figure 93. CASEVAC Final Review Prior to Final Redesign

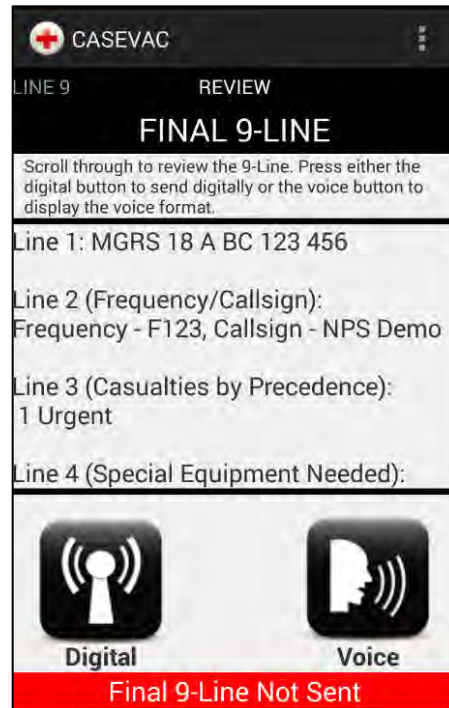


Figure 94. CASEVAC Final 9-Line After Final Redesign

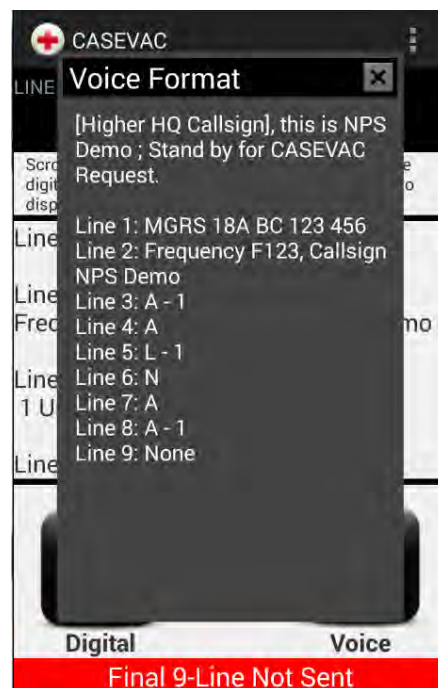


Figure 95. CASEVAC Voice Transmission Format

3. WireShark Testing

After several redesigns of the CASEVAC application, we wanted to determine if improvement to the user interface or the data packet would give us the greatest benefit in increasing the efficiency of the application. WireShark was utilized to capture the application's data packet and conduct the analysis. We focused on two packets in particular to analyze. The first packet was a MEDEVAC request that the user only selected the bare minimum needed to submit a request i.e., only one casualty and the bare minimum per line. This bare minimum request only required 310 bytes to transmit the request. Next, we maxed out every field in the CASEVAC application or selected as many buttons as possible per line. This request was for 999 casualties and with all options selected, and this only required less than 400 bytes to transmit the request to the server. Figures 96 and 97 represent a WireShark capture of the data being transmitted over the NPS Wireless Network for the minimal casualty request.

No.	Time	Source	Destination	Protocol	Length	Info
605	6.543110000	172.20.146.46	172.20.146.55	TCP	74	39047 > upnotifyp [SYN] Seq=0 Win=14608 Len=0 MSS=1460 SACK_PERM=1 TSval=3002334 TSecr=0 WS=64
607	6.545810000	172.20.146.46	172.20.146.55	TCP	66	39047 > upnotifyp [ACK] Seq=1 Ack=1 Win=14656 Len=0 TSval=3002334 TSecr=557310812
609	6.547713000	172.20.146.46	172.20.146.55	TCP	68	39047 > upnotifyp [PSH, ACK] Seq=1 Ack=1 Win=14656 Len=2 TSval=3002335 TSecr=557310812
611	6.553373000	172.20.146.46	172.20.146.55	TCP	68	39047 > upnotifyp [PSH, ACK] Seq=3 Ack=1 Win=14656 Len=2 TSval=3002335 TSecr=557310815
632	6.557633000	172.20.146.46	172.20.146.55	TCP	66	39047 > upnotifyp [ACK] Seq=5 Ack=5 Win=14656 Len=0 TSval=3002336 TSecr=557310820
633	6.557919000	172.20.146.46	172.20.146.55	TCP	67	39047 > upnotifyp [PSH, ACK] Seq=5 Ack=5 Win=14656 Len=1 TSval=3002336 TSecr=557310820
635	6.560931000	172.20.146.46	172.20.146.55	TCP	376	39047 > upnotifyp [PSH, ACK] Seq=6 Ack=5 Win=14656 Len=310 TSval=3002336 TSecr=557310824
639	6.594342000	172.20.146.46	172.20.146.55	TCP	66	39047 > upnotifyp [ACK] Seq=316 Ack=49 Win=14656 Len=0 TSval=3002341 TSecr=557310027
641	9.395580000	172.20.146.46	172.20.146.55	TCP	66	39047 > upnotifyp [FIN, ACK] Seq=316 Ack=49 Win=14656 Len=0 TSval=3002341 TSecr=557310827

Figure 96. WireShark Trace

▶ Frame 635: 376 bytes on wire (3008 bits), 376 bytes captured (3008 bits) on interface 0
▶ Ethernet II, Src: SamsungE_16:0a:1f (20:64:32:16:0a:1f), Dst: Apple_78:5e:e0 (7c:d1:c3:78:5e:e0)
▶ Internet Protocol Version 4, Src: 172.20.146.46 (172.20.146.46), Dst: 172.20.146.55 (172.20.146.55)
▶ Transmission Control Protocol, Src Port: 39047 (39047), Dst Port: upnotifyp (4445), Seq: 6, Ack: 5, Len: 310
▶ Data (310 bytes)

Figure 97. WireShark Packet Capture

4. WireShark Analysis

It was not a big surprise that the data packet size was small, but we were a little surprised that there was very little difference between the smallest request and the largest request. In addition, the WireShark capture confirmed our belief that our main focus at this point in development should be on improving the user interface as much as possible. This is because the average time to generate a request was 150.7 seconds. While, the data

packet is extremely small, 400 bytes at the most, trying to reduce the data packet at this point would not be as great of a gain as trying to reduce seconds off of the time to generate a request.

H. INTERMEDIATE TEST

The purpose of the intermediate phase of testing was to evaluate the CASEVAC application in a medium stress environment. The testing set-up and users' background for intermediate testing are discussed below.

1. Test Set-up

For this test, 4 groups of an average of 10 users were given a 30 minute presentation on MEDEVAC procedures, a 5 minute demonstration of the phone and CASEVAC application, 5 minutes to explore the phone and application, and a question and answer period. Following the presentation and demonstration, the users were divided into two groups of five. Each group was given the same two-page scenario that was used in the early rounds of testing. However, in one group each member of the group was given the Galaxy Nexus with the CASEVAC application on it to submit the request. The other group was only given a "cheat sheet" (Appendix B) with an outline of the CASEVAC format and screen shot of a GPS to help them submit the request.

In this phase we set up an access point using a Wave Relay Radio by Persistent System (described in the following section) in order to allow the phone to submit the request to the server located on a laptop in the room. We stopped the time of the request for the individuals in the group with the phone when the request was received on the server. For the group without the phone we stopped the time when the individual was prepared to transmit the request over the radio.

2. Wave Relay Radio

The Wave Relay radio is a Mobile Ad Hoc Networking System (MANET), which allows the user to maintain connectivity on the move and is similar in size to the PRC-152 radio currently in use by the military [36]. The radio has the ability to perform push to talk (PTT) voice, data transfer, and video transfer. It has the ability for a layer-2

Ethernet connectivity, which facilitates plug-and-play of cameras, IP sensors, video encoders and other devices [36]. It can be used as a wireless access point, which is how it was utilized in our testing. Finally, the Wave Relay Radio is capable of throughput of 41 Mbps using UDP and 31.1 Mbps using TCP. Other key specifications are listed in Table 2.

Wave Relay Radio Selected Specifications	
Weight w/ battery	1.1 pounds
Battery life	14 hours
Size w/ battery	7.8 x 3.0 x 1.5 in
Networking	802.11a/b/g AP compatible, IPv4 and IPv6 compatible, Dynamic Line Exchange Protocol Certified
Security	Utilizes Suite B algorithms, Active response to tamper, AES-CTR-256 with SHA-512 HMAC, FIPS 140-2
Push to talk	Supports 16 channels
GPS capable	Yes

Table 2. Wave Relay Radio Selected Specifications, after [36]



Figure 98. Persistent Systems Wave Relay Radio, from [36].

3. Users' Background

During this test we were able to get access to the target audience, which is junior service members untrained on MEDEVAC procedures. Defense Language Institute (DLI), which is located in Monterey, CA only a few miles from NPS, provided a perfect pool of users to test the CASEVAC application. The users were drawn from the group of junior Marines waiting for their training to begin. The vast majority of these Marines have less than a year in the Marine Corps and no experience with MEDEVAC procedures. The average experience level with MEDEVAC procedures for the 38 individuals drawn from this group for testing was 1.8, which puts the average just below informal training. Furthermore, the users' average rank was Private First Class or E-2, and they had an average of eight months in the military.

4. Intermediate Test Results

The timing and survey results from the intermediate testing are discussed below.

a. Time

As mentioned earlier, we broke the users into two equal groups of 19 individuals per group, one group used our CASEVAC application and the other used traditional means to submit the request. Timing for this phase of testing was recorded differently for each group. The time for the group that used the CASEVAC application started when the user opened the application and stopped when the user submitted the request to the server. This is no different than how time was recorded earlier for previous tests. The time for the group that used the traditional means of submitting a MEDEVAC request was started by the evaluator and stopped when the individual had formulated their request and was ready to submit the request via the radio. The transmission time was not recorded because people transmit at different speeds and between the two methods the CASEVAC submission time would always beat the traditional means. The average time for the group using the traditional method was 251 seconds to formulate the request. The fastest time to formulate the request using traditional methods was 109 seconds and the slowest was 390 seconds. Again, the time for the traditional method does not include the transmission time needed to submit the request to higher headquarters. One could easily

add on at least 30 seconds to this time, in the best-case scenario, to allow for transmission of the request to higher headquarter. Also, one needs to consider the time needed for the radio operator to record the request and input the request into the proper chat window. The average time for the group using the CASEVAC application was 131 seconds, which included submission to the higher headquarters. The fastest time using the application was 50 seconds and the slowest time was 204 seconds. The application group needed on averaged 120 seconds less to formulate and submit their requests compared to the group without CASEVAC that only formulated but did not submit their request. See results in the Figures below.

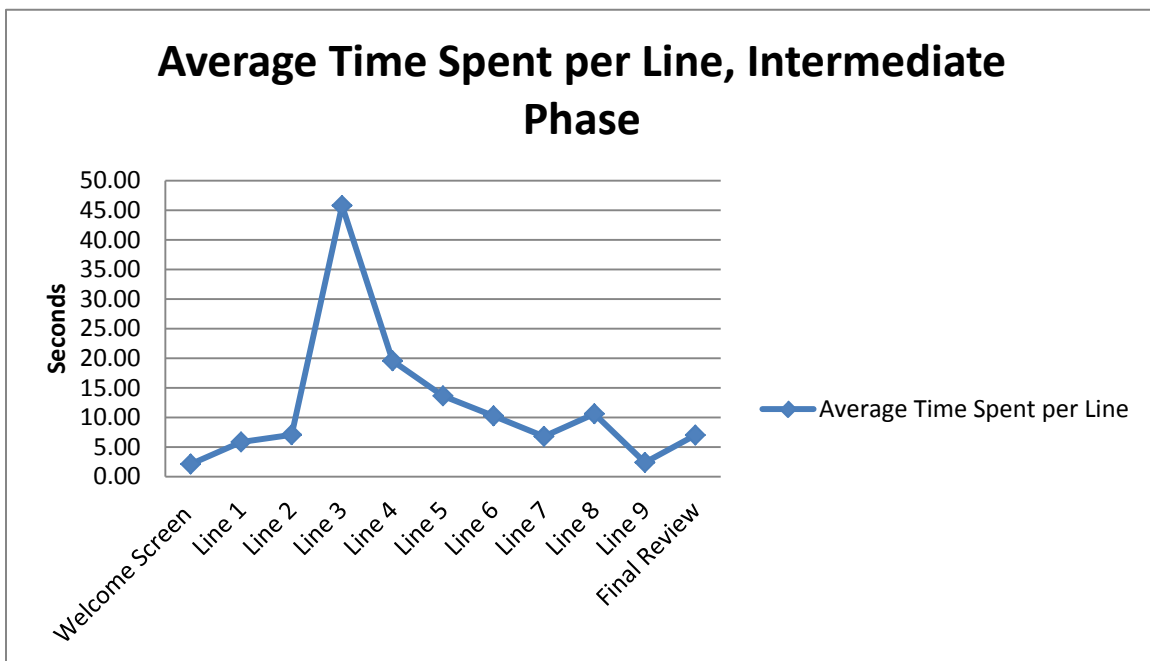


Figure 99. Average Time Spent Per Line, Intermediate Phase

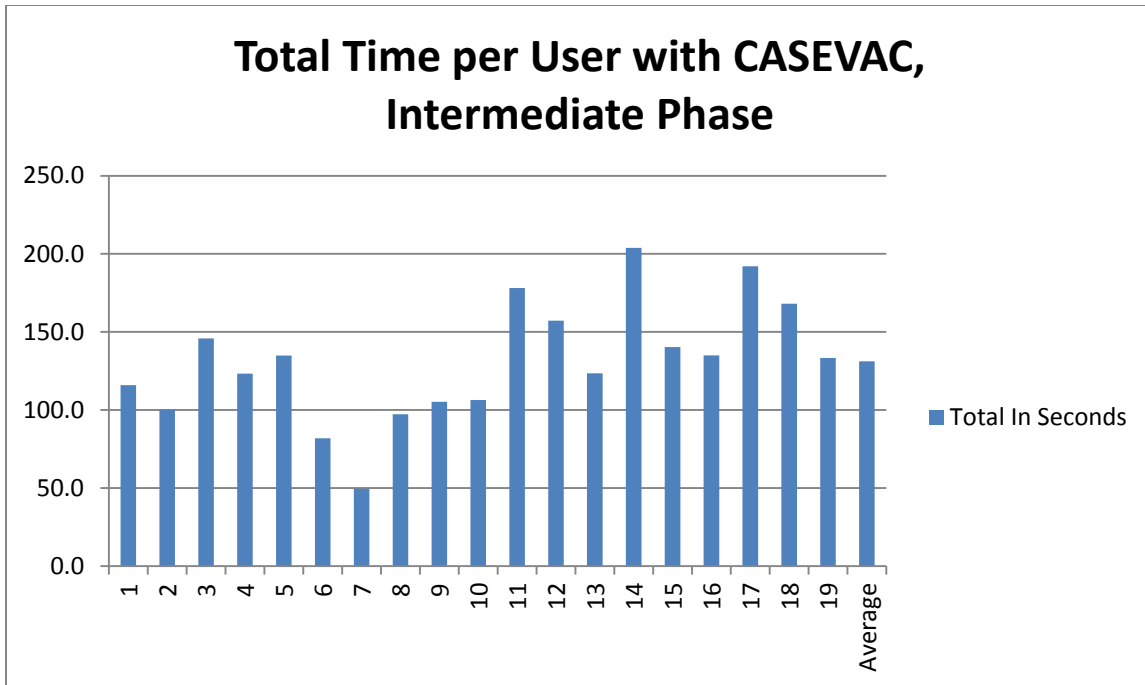


Figure 100. Total Time per User with CASEVAC, Intermediate Phase

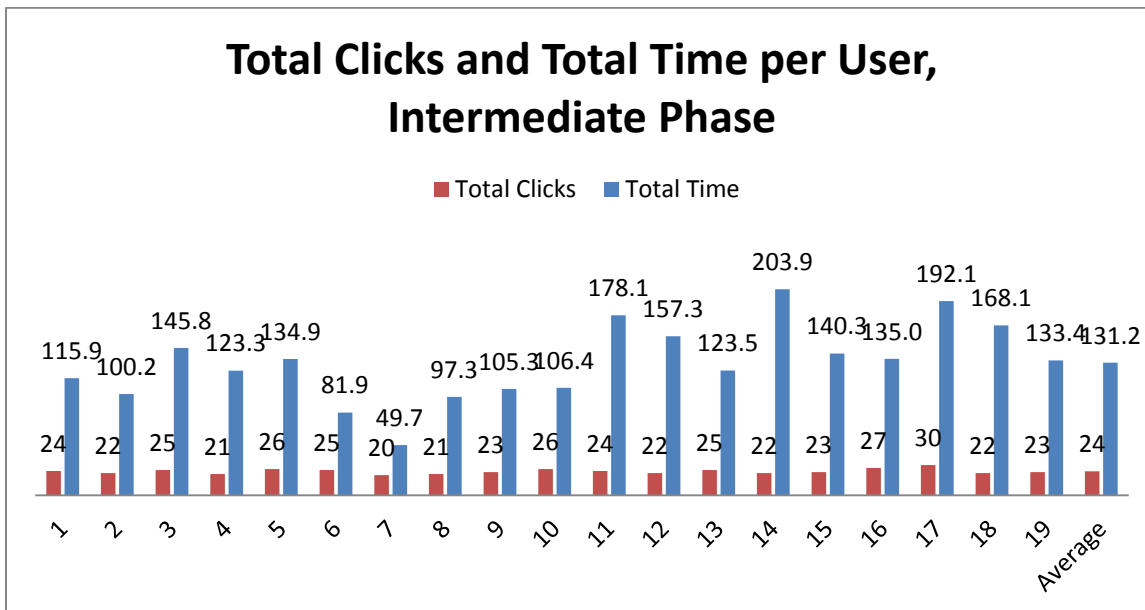


Figure 101. Total Clicks and Total Time per User, Intermediate Phase

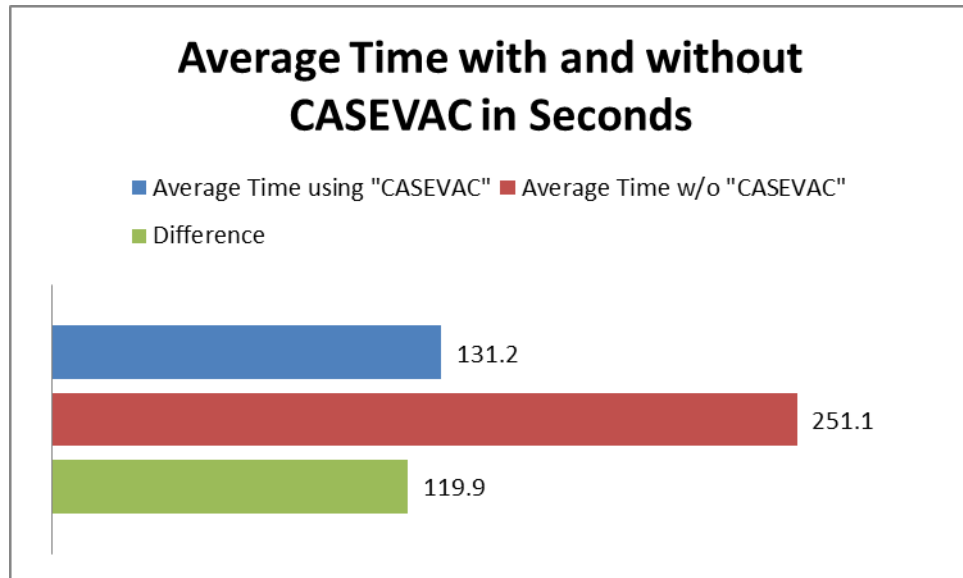


Figure 102. Average Time With and Without CASEVAC

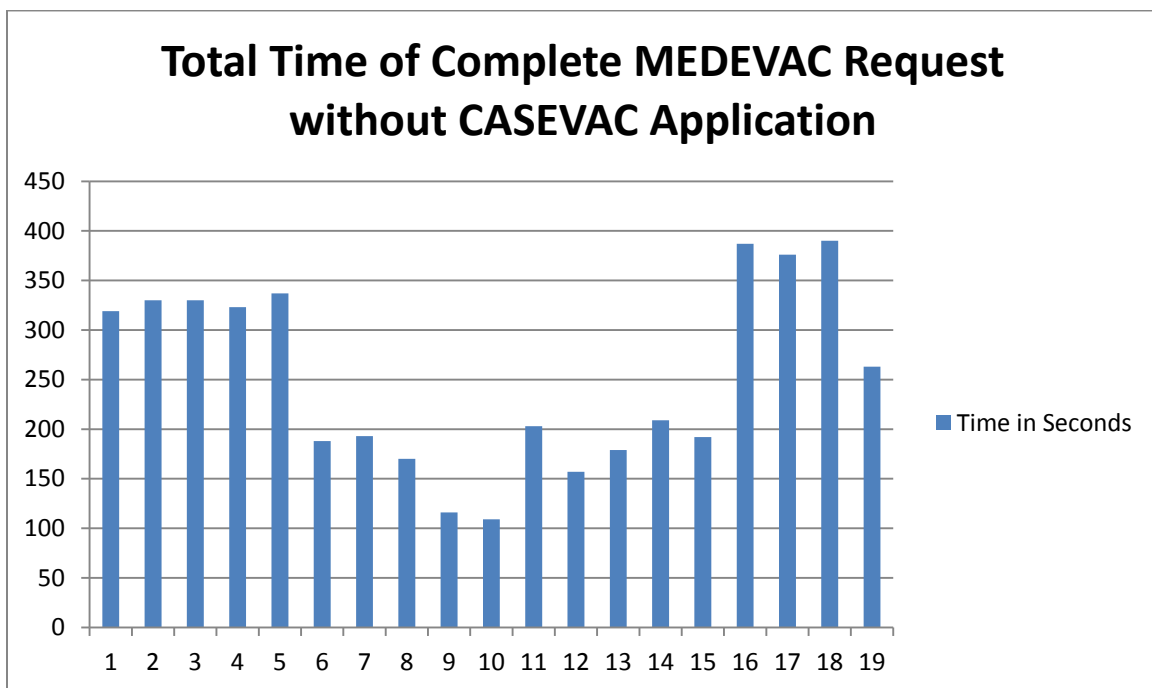


Figure 103. Total Time of Complete MEDEVAC Request Without Application

b. Survey 1 Results

The average overall score for Survey 1 was 93.5 with a range between 78 and 100, and the per-category range was between 4.60 and 4.98, see results in Figure 104 and Figure 105.

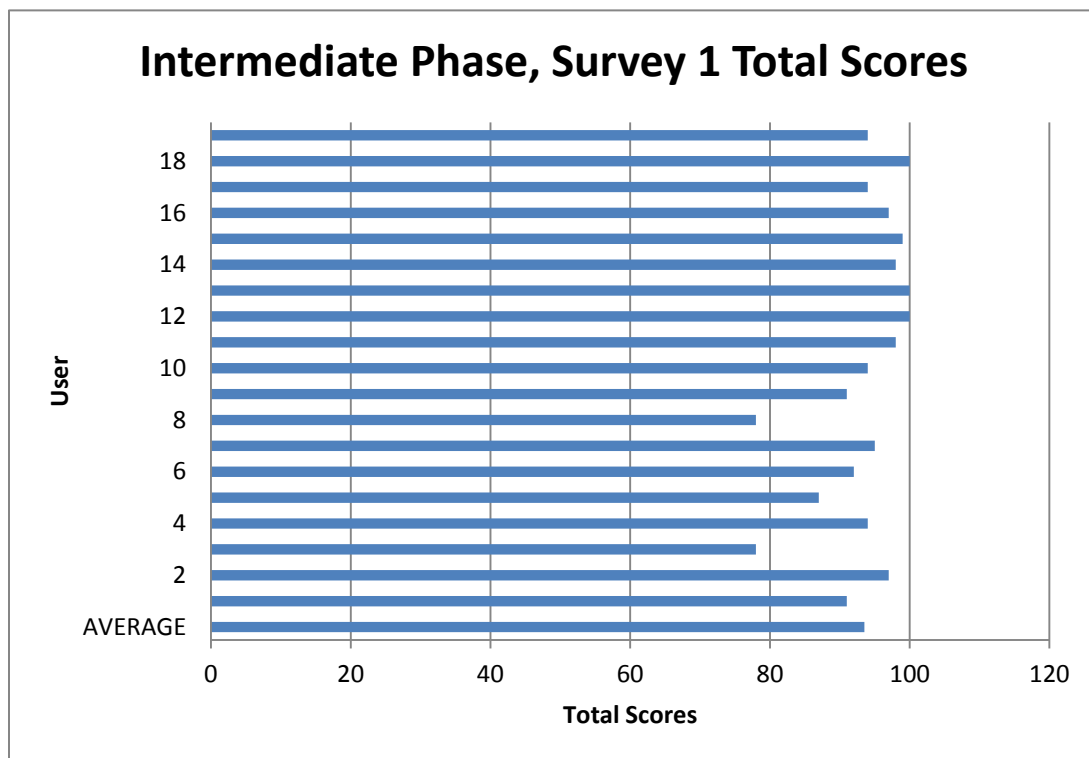


Figure 104. Intermediate Phase, Survey 1 Results

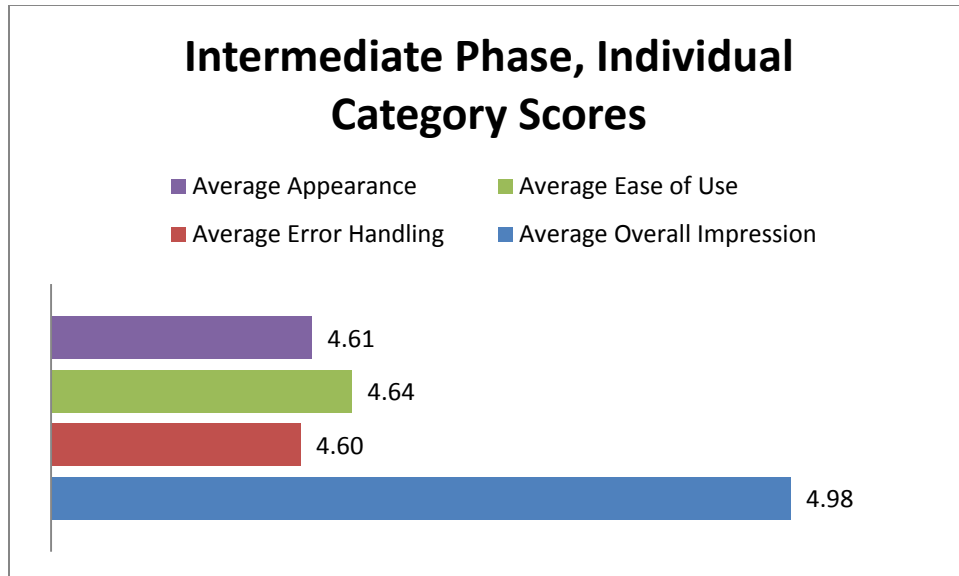


Figure 105. Intermediate Phase, Individual Category Scores

c. Survey 2 Results

Selected comments from Survey 2 in the immediate testing phase:

(1) Liked features

“GPS Feature...”

“The simple way it walks you through each line and the information required.”

“The check box format was simple and easy to use.”

“Easy for anyone to use even without formal 9-line training.”

“The ability to see definition for the terms...”

(2) Disliked features

“The plus sign proximity to the term several time [I] went to increase a number but instead had the definition box pop-up.”

“Some buttons could be made larger.”

“The inability to clear the app without closing it.”

(3) Need to add to application

“The GPS and Transmit buttons could be colored.”

“When the bottom bar turns green, it should flash more noticeably...”

“Add tabs so you can instantly flip between any line in case you have to make a correction...”

“add ‘?’ to the definitions to show they contain definitions....”

d. Error Rate

This phase of testing gave us the opportunity to compare the error rates of the traditional methods of submitting a MEDEVAC request (using a cheat sheet to generate the request) against our CASEVAC application. Errors in the MEDEVAC request can range from slowing down processing of the request, to the possibility of not sourcing the correct number of evacuation platforms, or even sending the casualties to the wrong level of treatment facility.

We considered that every line in the request could be a possible error, so a user could make up to nine errors in the one request. Below is a list of inputs by a user, which counted towards an error:

- Obvious wrong precedence level for a patient, for example user selected “routine” for an individual with a missing leg, which should be an “urgent surgical.” However, we did not consider it an error if the user was within one precedence level, for example the user selected “urgent” for a “urgent surgical” or vice versa.
- Selecting the wrong special equipment
- Entering in the location of the pick-up site in wrong format (odd number MGRS)
- Selecting the wrong method of marking for the pick-up site
- Selecting the wrong number of patients
- Selecting the wrong patient nationality

In this test, the 19 users using the CASEVAC application, only had a combine total of 7 errors out of a possible 171 lines, which was a total error rate of 4.1%. The users using the traditional method nearly tripled that number with a total of 18 lines with an error for the same number of requests, which gave the group a total error rate of 10.5%. It should be mentioned that this group’s error rate does not include transmitting the request to the radio operator, the radio operator recording the request, and then entering the request into the proper chat window, which will naturally increase the probability for errors. However, with the CASEVAC application, all the radio operator has to do is copy the submitted request from the server window and paste the request into the proper chat window, which is only one step compared to the three steps needed by the traditional method to input a MEDEVAC request.

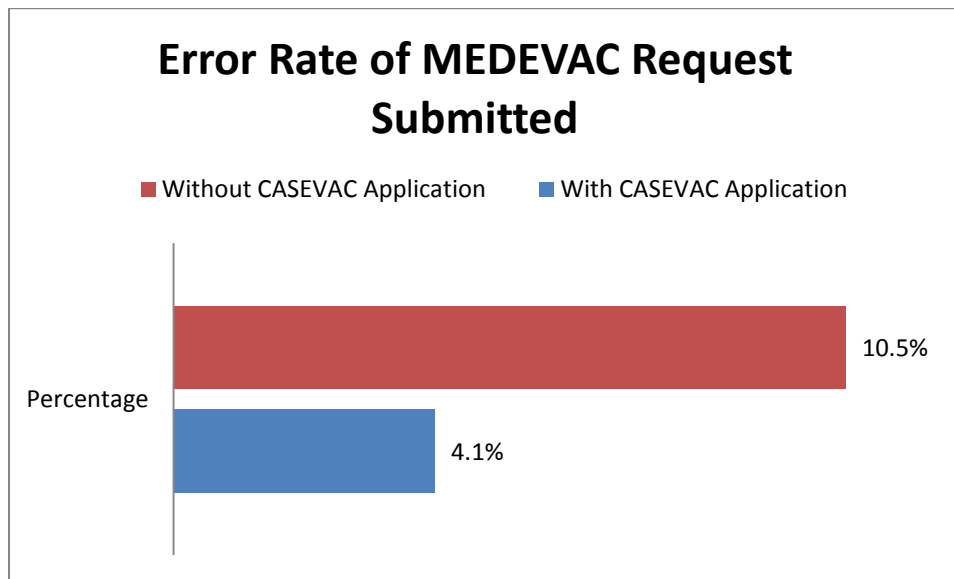


Figure 106. Error Rate of MEDEVAC Requests

I. ANALYSIS AND REDESIGN AFTER INTERMEDIATE TESTING PHASE

The analysis of the intermediate testing results and the redesign implemented based off of observation and user feedback are discussed below.

1. Analysis

The test results from the Immediate Test prove that the CASEVAC application is a good alternative to the traditional methods of submitting a MEDEVAC requests. We continued to have above a rating of 4.6 out of a maximum of 5.0 in all categories for Survey 1, which has been maintained since the beginning of testing because of the many redesigns of our layout and flow of the application suggested by users. The testing showed a decrease of 20%, 19.5 seconds, in the amount of time needed to submit a request using the CASEVAC application from the last round of testing, even though the experience level with MEDEVAC procedure was lower than the round before. This dramatic reduction in time again validates the major redesign of the application. Additionally, the total number of clicks went from 35 down to 24, which is a reduction of

30%. This round of test not only showed that users submitted their request faster than in earlier test rounds, but that the users using the CASEVAC application could generate and submit a request an average of two minutes faster, with less errors, than their peers using traditional methods to submit a MEDEVAC request. This increase in speed and accuracy gives the patient precious time that can be utilized by evacuation units and medical personnel to deliver key medical treatment to the patient within the “Golden Hour.” Overall, the test results for Intermediate Testing Phase were positive and we feel based on the feedback received during this phase that we could move onto the Field Testing Phase after making minor adjustments to the CASEVAC application that were mentioned in Survey 2.

2. Additional Improvements to implement based off Intermediate Testing

The improvements outlined in the following subsections would have been made if time permitted based off of observation and user feedback.

a. Highlighting Key Button and Changes

We would do more to make key buttons in the application more prominent to the user. Example buttons would be the “Click to Use Device GPS” button and the “Click to Use Preset” button located respectively on screens 2 and 3. Most likely we would not only increase the size of the buttons but make the buttons a different color as well or find another means in which to make them stand out more on the screen. Next, we would explore means in which to draw the user’s attention to the bottom part of the screen when the line at the bottom changes from red to green or vice versa. This could be accomplished with a combination of methods, which include increasing the size of the line or making the line flash for a period of time.

b. Helpful Definitions Improvements

The amount of positive feedback that the users expressed about the definition of key terms within the application prove to us that they are needed and extremely helpful. However, we did receive some negative feedback that signals that we can improve on the

delivery on this information. The first improvement is to find a better method of informing the user that there are helpful hints within the application. This could be accomplished by making words with helpful hints different colors or adding a ‘?’ to the corner of every word. The second improvement is to reduce the chance of a user accidentally selecting the helpful hint box. This could be done by adjusting the target area in which the user needs to press to trigger the hint box, but we need to be careful not to make the target area too small that way the user can still easily select the hint when needed. The last improvement that needs to be made is to make the helpful hint box easier to close, whether it is opened on purpose or accident. Currently, one can only close the box by pressing the ‘X’ in the upper left-hand corner. The size of the ‘X’ needs to be increased or a different type of helpful hint box with a larger surface area to close the box needs to be used.

J. CHAPTER SUMMARY

Our tests were positive and proved that the CASEVAC application could be a viable option in submitting a MEDEVAC request on the battlefield. The tests prove that an untrained user with little to no training on the application or MEDEVAC procedures can submit a request faster and more quickly and accurately than a peer with similar training. Furthermore, the testing proves the military does not need the most technologically advanced smartphones to achieve these types of results, and shows what could be achieved if smartphones were available to both trained and untrained individuals on the battlefield.

V. CONCLUSIONS

A. HYPOTHESIS TEST RESULTS

Throughout our application testing, it became very clear that our hypothesis presented in chapter 1 was confirmed. The entry level Marines, with little to no prior training, performed in a superior manner when using HELP. Those using the application took, on average, approximately half of the time to finalize the request and made approximately half of the errors versus those who used traditional pen-and-paper means.

B. SECONDARY RESEARCH QUESTION RESULTS

1. Which sensing modalities of current COTS mobile devices can be used to facilitate rapid request generation?

The primary sensing modality that we employed was the GPS. Simply being able to click a button to display the current location, results in a huge time savings over traditional means.

2. What measures can be taken to prevent errors in the generation of call for resources?

A simple user interface is the key to error prevention. We feel that breaking information down to manageable chunks assists users by making it easier for them to manage the complexity of the process. The user is able to focus on the required input for a single line and move on when ready.

Additionally, digital communication capability greatly reduces the number of errors by eliminating the inherent difficulties of transmitting large amounts of complex information over a voice radio.

3. What measures can be taken to make the application usable in stressful environments?

Our users told us that haptic feedback was critical to error prevention. Both the built-in vibration capability and simple color-changing techniques benefits the user by indicating when something has changed.

4. What are the time and accuracy benefits to using a handheld device compared with traditional methods?

Users of our application completed a simple CASEVAC scenario in 50% of the time and with 50% of the errors when compared with a manual group. The average amount of saved time was approximately two minutes, *without* factoring in voice transmission time.

5. Can an untrained Marine or Soldier use the device with little or no prior training?

The answer to this question is a resounding “Yes.” With only a few minutes of introduction on the device, entry level Marines were able to successfully use our application.

6. What are the security concerns when dealing with individual mobile devices?

Security will always be a concern when using any digital device communication device. However, as the transmission of the request is a simple string array, the technology already exists to provide secure transmission. Data at rest is another issue, but that is beyond the scope of our thesis.

C. PLATFORM

HELP was tested on a smartphone that would be considered out-of-date when compared against the state-of-the-art devices and certainly not designed to handle the rigors of military use and extreme conditions. So before any field-testing began, we carefully considered which type of device or devices the HELP suite would be deployed on in the military. We do not recommend any particular device or devices because new ruggedized devices are being released at a fairly regular rate ranging in price from \$500–\$1000, and any recommended device would most likely be out of date by the time action

is taken to test the device or devices. However, some obvious features that would be needed in the device before it is adopted for use are listed below:

- Able to run Android Operating System
- Waterproof
- Long battery life and replaceable battery
- User friendly interface
- Easy to upgrade
- Ruggedized to military standard

Another route to explore instead of a ruggedized smartphone is the development of a case to protect a non-ruggedized device, which would allow the device to be used under military conditions. This option, if feasible, would give the military more options in COTS devices from which to select. Finally, the military could always have a company build a device especially for the military, but this option would be by far the most costly.

D. FUTURE WORK

This section discusses future work that needs to be conducted to further evaluate HELP as an application that could be used in a combat environment.

1. Field Testing

Future testing needs to be conducted in a field environment to properly evaluate HELP for future use.

a. Recommended Venue

Unfortunately, because of several constraints, we were not able to conduct any field testing. While initial and intermediate testing phases' results were positive, field testing needs to be done to verify the application can properly be utilized on the battlefield by users of all experience levels and under all environmental conditions. There will need to be several rounds of field testing before the application will be ready for deployment to the operating forces; however, the best place to start this testing would be the Infantry Immense Trainer (IIT). There are three IITs located in the Marine Corps. The IIT is a facility that simulates a combat environment in all aspects from sights and sounds

to simulated casualties. The IIT would be ideal for initial field testing because the facility can control numerous variables and the facility numerous cameras that can be leveraged to observe the user of the application from many different angles in the compound. With the initial field testing done at an IIT the evaluation of the results would be easier because of the facility's ability to control variables.

2. Security

During the development of our applications security was not the primary concern. While we knew security was important, our efforts were focused on proving that a smartphone application could be used by untrained users to submit a request in a stressful environment. Now that we proved that it's possible, attention needs to be given to the applications' security.

a. Data at Rest

When the HELP application is opened it creates a database that is used to store information about the user's unit and higher headquarter. The database is then referenced by the other three applications to retrieve this information to speed up the construction of the request. This database on the phone could be exploited by unauthorized users if the phone were to find its way into unfriendly hands or be hacked. Work needs to be done to find the best method to secure the database from unauthorized users while the phone is at rest. This could be as simple as encrypting the database to a more complex security protocols. Whatever method is used, one must consider the effects that the security measures will have on the performance of the applications and its ability to access the information in the database quick and efficiently.

b. Data During Transmission

To transmit the request from the phone to the server we used the Wave Relay Radio to establish a Wi-Fi hotspot which the phone uses to push the request to the server. The access point uses WPA2 to encrypt the request as it moves from the smartphone to the Wi-Fi hotspot. WPA2 requires a password to gain access to the access point and is used by many businesses and government agencies to secure their wireless traffic.

However, analysis needs to be conducted to determine if WPA2 meets the security requirements for the military for the information that is being transmitted by the requests. We expect that WPA2 will not meet the military's security requirements so research needs to be conducted on what is the best method to secure the requests during transmission but not create too much overhead, so the security measures do not become a burden of the user or the bandwidth available.

c. Two-Way Authentication

Currently the application submits the request to the server and there is no authentication done by the application or the server to prove a device's identification or if the device has permission to submit or receive the request. This arrangement between the application and the server would not work in the realistic military settings as unfriendly users could, with some effort, spoof the application or the server. This could lead to fake requests being submitted or false acknowledgments sent to the application, and one can imagine the many issues this would cause.

Research needs to be conducted to determine the best method for mutual authentication between the application and the server. Many organizations in the government and the private sector have protocols they use for their mobile application that already solve this challenge. The issue would be to find the protocol that meets the military's requirements while at the same time as not creating an undue burden on the application or the server.

3. Additional Features

Many additional features were suggested by the users who tested the application, and we thought of several others as we went through the development of the applications. Below is a list of the top seven features to add that we did not get the chance to implement because of time or coding experience constraints.

a. Z-MIST Report

The CASEVAC application currently only submits the standard NATO MEDEVAC request and not the follow-on Z-MIST Report. Z-MIST stands for Zap

number and blood type, Mechanism of injury, Injury sustained, Signs and system, Treatment given. The Zap number is a number given to military personnel by their unit to identify them over the radio without having to say their actual name. The Z-MIST report is used to give the higher headquarters and the medical personnel better situational awareness. The report identifies the actual individual injured and more importantly the extent of the patient's injuries. The Z-MIST report is or was used in Iraq and Afghanistan and is sent immediately following the standard NATO MEDEVAC request. The CASEVAC application could be modified so that after the user submits the MEDEVAC request the application would take the user to a different screen to start the generation of the Z-MIST report for each patient. The flow of the application to complete the Z-MIST report should be similar to the flow used to enter the standard MEDEVAC request, and should dynamically create the proper number of Z-MIST reports based on the information entered earlier by the user.

b. QR Code

Quick Reader Code or QR Code, which is its more popular name, is a matrix type barcode that has seen widespread use in numerous industries. Currently businesses are using QR Codes on advertisements to provide individuals with additional information or a link to a website by scanning the QR code located on the advertisement with a QR code reader [37]. QR Codes are easy to make and can store up to nearly 3000 text characters [38]. Today's smartphones can easily support a third party QR code reader application and some smartphones are now even being released with native QR code readers.

The use of the QR code for the CASEVAC or Rapid Request applications would greatly increase the speed and efficiency of the user. Take the implementation of the QR code reader in the CASEVAC application as a prime example if the Z-MIST report was added to the application. All individuals deploying to a combat zone get issued at least three identical laminated small pieces of paper that contain their zap number, blood type, allergies, and serialized gear assigned to them. These pieces of paper are referred to a zap or kill cards by service members, and they are placed one in an upper uniform pocket, one in a lower uniform pocket, and the last in their medical kit. If a service member is

injured the zap cards are used to give the person requesting the MEDEVAC key information needed to complete the Z-MIST report.

QR codes could be leveraged to speed up the generation of the Z-MIST report by adding a QR code to the zap cards, with the patient's information needed in the Z-MIST report stored in the QR code (Figure 107). Next a QR code reader could be easily implemented into the CASEVAC application, which would allow the application to read the QR code on the zap card and automatically populate several fields within the Z-MIST report. QR codes could be leveraged for the Rapid Request application by adding QR codes to military supplies so all an individual has to do is scan the code on the item and input the quantity that they want, instead of manually entering in the item.



Figure 107. Sample QR Code Example

c. Historical Entries

There are several locations in all the applications where the user is required or has the option of manually entering information for a particular field via the keyboard. To increase the speed and efficiency of the user, the applications should store previous entries and allow the user to access those entries when typing in that particular field. We envision a drop down like menu that dynamically changes based on previous inputs from the user. This menu would appear when the user is typing in a field and allow the user to select from a previous list of inputs for that particular field only. This would help reduce the time and error rate when generating a request. Below is a picture similar to what we envision.



Figure 108. Historical Entry Example, from [39]

d. Form Reset

None of the applications that we created have the ability to reset all fields within the applications without closing down the application completely, and we realize this could be an issue in the future. To correct this, there needs to be away for the user to completely reset all the fields within the application quickly. This feature needs to be easily accessible but not too accessible so that the user could accidentally reset the request unknowingly. We believe that the best place for this feature is in the drop down menu located in the top right-hand corner of every application. The location of the form reset option here gives the user the ability to access it from any screen within the applications, and being located in the drop down menu protects it for accidentally being selected. However, in case the button is accidentally selected the users should be required to verify they want to reset the form before it is actually reset.

e. Real Time Request Status

The applications currently within the HELP suite only receive feedback from the server when the server has successfully received the respective request. A feature to improve the communication between the application and the server is to allow the server to send messages to the application about the status of the request and the application has

the ability to respond to those messages. This added feature would operate very similar to text messages. This feature would give users of the applications and the server operators the ability to clarify information or pass updates to a request without ever having to get on the radio, which is important for two reasons. First, the user that is sending the request may not have access to a radio. Secondly, it will help eliminate administrative traffic over the radio, especially when it comes to dealing with the “Rapid Request” application. Just like all added features, care must be taken to ensure that the applications do not become too complex so it will not impede the user’s ability to quickly and efficiently submit a request in a battlefield situation.

4. GUI Server

There is a lot of future work that can be done on the server to allow HELP to be better utilized in a combat environment. The following sections offer a list of upgrades that needs to be accomplished.

a. Upgrade from Simple Console

The server that we developed for this thesis is basic and is run from a command line. While, this simple server worked well during the development of the applications and in testing, it is not user friendly or robust enough to be used by the average computer user. Time needs to be spent developing a Graphical User Interface (GUI) server that is capable of being used by the average service member with little training. The layout of the GUI should mirror any number to GUI servers that are currently on the market or open source, but be modified to meet the military’s requirements. An example of this is the GUI server should have a tab for each request it could possibly receive, and a way to alert the operator that a request has been submitted without having the user constantly watching the screen. Time should be spent on determining the best design and features to add to the GUI, because no matter how quick the individual in the field submits the request, an individual at high headquarters must take that request and send it to the appropriate units in a quick and efficient manner as well.

b. Request Tracking

Due to the complex nature of many of the requests that can be submitted, there should be a means in which that request can be tracked to ensure the request are being fulfilled in a timely manner and to eliminate redundant requests. Requests should be easily submitted into a tracker program that allows the status or updates to the request to be modified with a simple click of a button. In addition, to tracking the current status of a request, the request tracker program could also serve as a central point for data mining to provide information on a number of topics from consumption rates for individual units to the response time for medical requests.

c. Integration with Tactical Chat Programs

The best GUI server created for the HELP suite is still very limited if the GUI server does not have the ability to interact with the current and future tactical chat programs. A properly formatted request should be transferred into the proper tactical chat window to get the request fulfilled and to eliminate the opportunity for human error as much as possible. The transfer of the request could range from cutting and pasting the request into the tactical chat window or one could develop a button so the operator just has to push a button to send the request to the correct tactical chat window. In either case, proper forethought must be given in the development of this feature to ensure it is as simple as possible to warrant the implementation of the HELP suite.

5. Training

Some minor work will need to be accomplished in order to introduce the system into the operating forces.

a. Training and Readiness Manual Entry

Before any software is deployed across the military a training program needs to be created to ensure individuals know how to properly use the software and know how to evaluate and train individuals on the software. One of the steps in this process is to develop a new training and readiness (T&R) standard in order to determine under what conditions individuals will be required to use the respective application, what must

accomplish, and in what timeframe. If a proper T&R task is not inserted into the appropriate manual units will not be likely to train on the application they are given. The insertion of a T&R task sends the signal that training on the application is important and should be taken seriously.

b. Evaluation Version

If the HELP suite is adopted as a program of record, there would be a need to develop two versions of the each application: training and operational. The difference between the two versions will be minor but the one used for training would provide the evaluators with more information than just the request. The training application could record a number of things for the evaluators from the total time to complete the request to the total number of clicks. The type of information that could be recorded is vast but the Program Manager would ultimately make the decision on what exactly the training version would be required to capture for the evaluators.

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APPENDIX

A. SCENARIO

Setting up the HELP Application

Please ensure the following information is entered into the HELP Setting Application (Replace “X” with number given to you by the evaluator)

- Unit: User “X”
- Net ID: F456
- Callsign: User “X”
- Higher HQ IP Address: 192.168.113.127
- Higher HQ Port: 4445

Use the test connection button to ensure you can connect to the COC

Once test connection is successful we the HELP application please wait for instructions from the evaluators

Operational Scenario for the CASEVAC Application

You are a linguist attached to an Infantry platoon that is on a combined daytime foot patrol with the Afghan Army. Because of your language skills, you are required to stay in the general vicinity of the platoon commander at all times. The mission of the patrol is to make contact with the village elders, and talk about the possibility of establishing a local police force in the village that is located 10 km from your patrol base.

The patrol makes contact with the village elders and the meeting goes well. On the way back to base one of the members of the lead squad steps on an IED. As the platoon commander goes forward to check on the situation the enemy opens up fire from a tree line about 200 meters to the East of the patrol.

The platoon commander immediately starts shouting commands to his squad leaders via voice and radio. After about 30 seconds the enemy fire starts to die down and reports start to come in from the squad leaders.

1st squad reports no additional casualties. The Marine that stepped on the IED has lost his leg, but a tourniquet is controlling the bleeding.

2nd squad reports 1 casualty, an Afghan soldier with a gunshot to the arm. Bleeding is being controlled by a pressure bandage and he is able to walk under his own power.

3rd squad reports 2 additional casualties.

The first casualty is the platoon sergeant, who has suffered gunshot wounds (one each) to the stomach and leg and is currently unconscious.

The second casualty, a Marine, has taken small bullet fragments to the arm from a bullet that ricocheted off a nearby wall. The individual is still able to move his arm and return fire.

Since the enemy is still in the vicinity and shooting at the platoon with a moderate volume of fire, the platoon commander doesn't want to take himself or a squad leader out of the fight to call in the MEDEVAC. The Lieutenant quickly tasks you with requesting the MEDEVAC for the four wounded individuals; there is a clearing directly south that is capable of supporting a rotary-winged platform landing.

Your mission is to submit a complete MEDEVAC 9-Line for the 4 wounded individuals as quickly as possible. A complete MEDEVAC 9-Line is one with all 9 lines filled out.

Scenario Reminders/Available Resources:

- The enemy is still firing at the patrol.
- You have a GPS available. Ask the evaluator at any point to receive your location.
- The patrol has plenty of smoke and air panels for marking the landing zone.
- There is a clearing just south of your position capable of supporting a rotary wing landing.
- There is no apparent NBC/CBRN Contamination.

Casualty Info:

- One U.S. Marine that has lost his leg below the knee from an IED and is currently conscious
- One Afghan soldier has a gunshot wound to the arm and the bleeding is being controlled by a pressure dressing. He is currently conscious and alert.
- One U.S. Marine with gunshot wounds to the stomach and leg that is currently unconscious.
- One U.S. Marine with bullet fragments to the arm that is conscious and still returning fire against the enemy.

B. CASEVAC CHEAT SHEET

CASEVAC CHEATSHEET

Line 1. Location of the pick-up site (LAT/LONG or MGRS).

Line 2. Radio frequency, call sign, and suffix.

Line 3. Number of patients by precedence:

- A-Urgent
- B-Urgent Surgical
- C-Priority
- D-Routine
- E-Convenience

Line 4. Special equipment required:

- A-None
- B-Hoist
- C-Extraction equipment
- D-Ventilator

Line 5. Number of patients:

- L-Litter
- A- Ambulatory

Line 6. Security at pick-up site:

- N-No enemy troops in area
- P-Possible enemy troops in area (approach with caution)
- E-Enemy troops in area (approach with caution)
- X-Enemy troops in area (armed escort required)

Line 7. Method of marking pick-up site:

- A-Panels
- B-Pyrotechnic signal
- C-Smoke signal
- D-None
- E-Other

Line 8. Patient nationality and status:

- A-U.S. Military
- B-U.S. Civilian
- C-Non-U.S. Military
- D-Non-U.S. Civilian
- E-EPW

Line 9. NBC Contamination:

- N-Nuclear
- B-Biological
- C-Chemical

C. SURVEY 1 “USERS OF THE CASEVAC APPLICATION”

Survey for CASEVAC Application–version number 1

Date (DDMMYY): _____

User # _____

1. What is your Service and current rank and pay grade (ex: USMC Sgt E-5)?
2. What is your age?
3. How long have you been in the military?
4. What is your MOS or Rate with a description (ex: 0302 Infantry Officer)?
5. Rate your experience with 9-Line Medical Evacuation procedures on a scale 1–5 (circle one)?
(1- No Experience, 2- Informal Training, 3-Formal Training, 4-Called in 9-Line in Training, 5-Called in 9-Line in Combat Environment)

1 2 3 4 5

6. What feature did you like the best and why?
7. What feature did you dislike the most and why?
8. What features do you feel need to be added to the application that are not currently there and why?
9. What screen do you feel you spent the most time on?
10. Which screen, if any, did you find confusing and why?
11. What are the greatest challenges that you think a user will experience in using this application?
12. Other suggestions or comments?

D. SURVEY 2 “QUESTIONNAIRE”

1 = Strongly Disagree 2 = Disagree 3 = Neutral 4 = Agree 5 = Strongly Agree		
Category	Score	
Section A: CASEVAC appearance	*****	
1. The colors for the application were appropriate 1 2 3 4 5		
2. The text was easy to read 1 2 3 4 5		
3. The buttons were easy to locate and press 1 2 3 4 5		
4. I don't notice any inconsistencies between the layout of different pages 1 2 3 4 5		
Section B: Ease of use	*****	
1. I always knew what to do next 1 2 3 4 5		
2. The time saving features were effective 1 2 3 4 5		
3. Important information was highlighted appropriately 1 2 3 4 5		
4. It required the fewest steps possible to accomplish the mission 1 2 3 4 5		
5. I could use the application with little or no instructions 1 2 3 4 5		
6. I always knew where to click 1 2 3 4 5		
7. I never felt lost during navigation of this application 1 2 3 4 5		
8. The hints were easy to find 1 2 3 4 5		
9. The hints provided were useful and easy to understand 1 2 3 4 5		
10. I never did something and got an unexpected result 1 2 3 4 5		
Section C: Mistakes and Error Handling	*****	
1. Mistakes were not easy to make 1 2 3 4 5		
2. I was immediately aware of any mistakes I made 1 2 3 4 5		
3. Recovery from mistakes were quick and easy 1 2 3 4 5		
Section D: Overall Impression	*****	
1. I thought various functions were integrated well (GPS, Pre-set) 1 2 3 4 5		
2. I see this application as being useful to the military 1 2 3 4 5		
3. I was satisfied with the application 1 2 3 4 5		
Total	/100	

E. SURVEY 3 “USERS OF THE TRADITIONAL MEANS”

Survey for CASEVAC Application–version 1

Date (DDMMYY): _____

User # _____

1. What is your Service and current rank and pay grade (ex: USMC Sgt E-5)?
2. What is your age?
3. How long have you been in the military?
4. What is your MOS or Rate with a description (ex: 0302 Infantry Officer)?
5. Rate your experience with 9-Line Medical Evacuation procedures on a scale 1–5 (circle one)?

(1- No Experience, 2- Informal Training, 3-Formal Training, 4-Called in 9-Line in Training, 5-Called in 9-Line in Combat Environment)

1 2 3 4 5

Time to prepare the CASEVAC request- _____

Please write down how you would have transmitted the 9-Line to higher headquarters

Line 1- _____

Line 2- _____

Line 3- _____

Line 4- _____

Line 5- _____

Line 6- _____

Line 7- _____

Line 8- _____

Line 9- _____

F. HIGH VELOCITY HUMAN FACTORS LAWS

The text in this subsection is extracted from a 2007 article by M. Rahman [13].

1. Law of Relevance

The human-machine interface (HMI) should aid the human agent to sense, perceive and lock-in on relevant cues (data\information) and make irrelevant cues, irrelevant.

Illustrations for the first law of HVHF

A digital display of the police car, when engaged in a high-speed pursuit, could morph as follows:

- The electronic digital speedometer could [dynamically] enlarge in size and occupy the entire display.

- The above would be facilitated by occupying the digital real estate, previously occupied by other digital gauges such as engine temperature, engine RPM, fuel gauge etc., which have now become irrelevant to the current context (high speed pursuit).

2. Law of Acceptance [of Relevance]

An HMI shall not aid or abet the agent from going into total lock-down (cognitive\visual tunneling) at the expense of becoming immune to relevant signals or all together missing newly emerging and relevant cues in the environment.

Illustrations for the second law of HVHF

- An interface should not overwhelm the senses and\or cognitive resources of the human agent to the extent that he becomes oblivious to the immediate, personal and local environment.
- An interface should be adaptive to the _context and workload of the human agent. For example, in a covert operating situation (context) and when the sniper (human agent) has locked-in on a target in a dynamic environment (high workload: moving target in a crowded field of innocent civilians), the interface should adapt in that it should suppress all alerts that are neither relevant to the current context nor urgent to the situation on hand.

3. Law of Transparency

An HMI shall not become a barrier to information that could and should be sensed directly from the immediate environment.

Illustrations for the third law of HVHF

- Poorly designed fire-fighter helmet-hoods, monocular Helmet Mounted Displays(HMDs) or night vision goggles may restrict peripheral vision and\or introduce binocular rivalry (in the case of monocular HMDs), and thus, may become a barrier rather than an aid during tactical operations.
- Heads-up Displays (HuDs) should not become opaque barriers on the windscreen of a vehicle and occlude information that could be gleaned directly in the immediate environment. Nor should they pose visual challenges (ocular motor) by requiring significant and rapid changes in focal length.

- Do not present information that can be sensed and perceived directly in the immediate environment on the display. Only relevant information that is beyond the reach and capabilities of the human senses—in terms of sensation threshold, amplification and resolution—should be presented.

4. Law of Clairvoyance

The HMI should assist the agent in imagining the future state of the world for a given course of action, or for an event that is already unfolding in real time.

Illustrations for the fourth law of HVHF

- Use technology to provide intelligence of various kinds (listed below), so that the agent can build a mental model of the current situation and to predict possible future states. This process—as rapid as it may be—should facilitate the agent mentally, simulate the possible courses of action and assist him in choosing the most successful course of action. Types of intelligence that technology should provide to the human agent (either on demand or a need to know basis):
 - On the scene intelligence (e.g., nature of conflict; number of people involved, their disposition [Hostage? Injured? Fugitive?], their capabilities [weapon? medical?], etc.
 - Technical intelligence (e.g., satellite imagery, maps & route information, scanning sensors—for beyond human sensory range sensing)
 - Tactical intelligence (e.g., number of officers involved and their capabilities; plan of actions [plan A, B...]; intra and inter agency command, coordination and control issues pertaining; use of stealth—i.e., ability to suppress one's own signal when employing elements of surprise)
- Use technology to predict the dynamics and future states of objects and people already in motion. For example, if an officer has requested a back-up—and has been dispatched—the interface should provide on the expected time of arrival at the destination; or in the event the officer who made the request is in motion, then, the time and place [in space] of intersection. In the case of a fleeing target, based on road conditions, traffic patterns, etc., information may be provided to the officer in pursuit regarding the time and place of probable interdiction with the target.

- The above should not come with a cost: obscuring information that is important in the local, personal and immediate context.

5. Law of Absoluteness

The HMI shall provide instant access to vital functions that need to be accessed in a split second by providing dedicated physical and tactile controls—including rapid cognition of relevant information—with a one-to-one mapping to the specific element that it would control. [13]

- Multi-sequence actions such as navigating through menus should be abhorred.
- In the operational sense, interactions with the interface should neither require deliberate thought nor fishing in space. (e.g., through a large array of controls to make contact & locate). That is, the designer should harness the kinesthetic memory of the human muscular system and make it independent of visual guidance to the extent possible.
- There are occasions when it becomes necessary to rapidly comprehend information with rough approximations rather than detailed information with a higher precision or resolution. For example, when the human agent is time constrained, a bar graph that shows the amount of fuel left (coarse numerical resolution) might be superior to reading-off a numerical value (e.g., 8.32 gal.) from a crowded display.

6. Law of Intelligence

Technology should be smart and adaptive and offload the human based on situation, context, and workload in a reliable manner. The agent should be “invited” back into the loop of action at appropriate moments when decision-making becomes the prerogative of human intelligence and not that of technology.

Corollary:

The human agent should be able to override functions allocated to technology or override decisions made by it at any time and at a moment’s notice (see Fifth Law on The Law of Absoluteness).

Illustrations for the sixth law of HVHF

- The adaptive cruise control in automobiles—the use of forward-looking RADAR to monitor the speed and distance of the vehicle in front—to

maintain a safe distance is an example of technology alleviating the human agent's workload.

- If a police vehicle has to enter a “stealth” zone (not reveal itself)—say, to interdict a hostage taker through the “surprise”—after speeding through traffic, the sirens and/or lights could be turned off.

7. The Law of Reliance

A solution, system or technology should be trustworthy and reliable almost to the point of being treated with reverence.

Illustrations for the seventh law of HVHF

- A motion sensor mounted on a police car is unable to discriminate between the movement of a tree branch and the approach of a person, thereby resulting in the disabling of the sensor or the need to assess the probable value of a warning.

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